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CORPS-WIDE CONFERENCE ON COMPUTER-AIDED DESIGN IN STRUCTURAL EN--ETC(U)
AUG 76 R M WAMSLEY, F J BOURGEOIS, D DRESSLER

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1 OF 5
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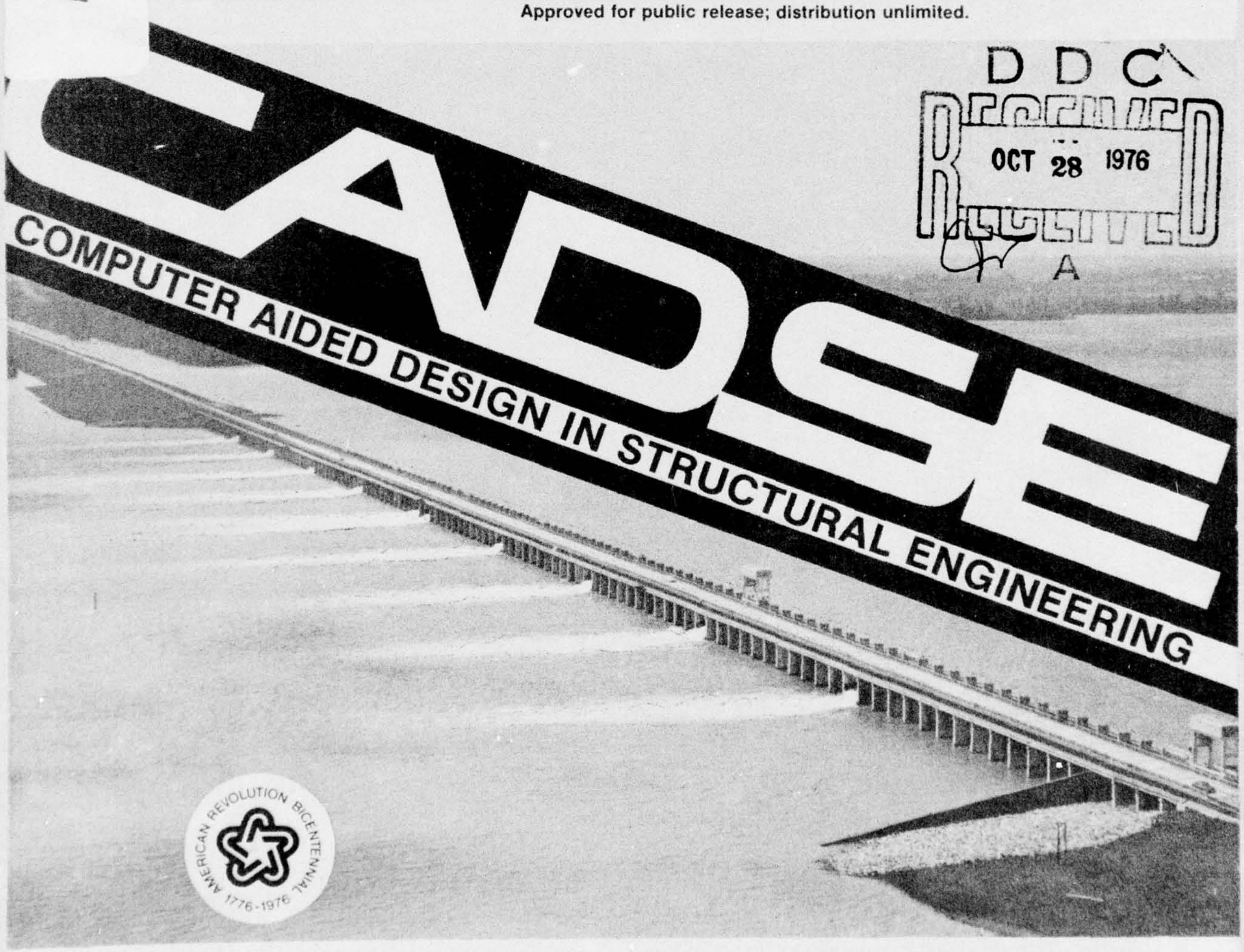
CORPS-WIDE CONFERENCE ON COMPUTER AIDED DESIGN IN STRUCTURAL ENGINEERING

22-26 September 1975

VOLUME IV
DIVISION PRESENTATIONS

Edited by N. RADHAKRISHNAN



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The papers in this volume were presented by representatives from each U. S. Army Corps of Engineers Division in the continental United States. The papers give an overall view of each Division, its area, responsibilities, and major problems. Geographical and environmental factors influencing the work are covered and the fraction of the work done by contractors and consultants is discussed. A major portion of many of the papers concerns the use of computers in the design and analysis of structures. Projects, types of computer service

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20. ABSTRACT (Continued).

used, cost and time savings, and design improvements are described. Also discussed are the means the Division uses for disseminating program information, starting new developments, publicizing improvements, discarding old programs, and which areas of structural design need more computer programs. Views on encouraging and controlling the development of computer programs for structural engineering are expressed and procedures and recommendations for both Division and Corps level operations are suggested. Problems experienced in program and equipment use are discussed. Many papers are accompanied by an appendix containing program abstracts.

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A

PREFACE

In December 1974, the Automatic Data Processing (ADP) Center, U. S. Army Engineer Waterways Experiment Station (WES), submitted a proposal to conduct a Corps-wide Conference on Computer-Aided Design in Structural Engineering to the Office of the Chief of Engineers (OCE). OCE approved the proposal and efforts were started in February 1975 to conduct this Conference. The Conference was conducted in New Orleans, Louisiana, 22-26 September 1975 and was attended by 175 engineers from 48 Corps field offices, OCE, Construction Engineering Research Laboratory, and WES.

This volume contains the papers presented by the following Division representatives:

Robert M. Wamsley, Structural Engineer, and
Frederick J. Bourgeois, Computer Specialist,
Huntsville Division

Donald Dressler, Structural Engineer,
Lower Mississippi Valley Division

Robert J. Hunt, Chief, ADP Office,
Missouri River Division

William J. Holtham, Structural Engineer,
New England Division

Alvis I. Eikstrems, Chief, Structural Section,
North Atlantic Division

J. P. D'Aniello, Civil Engineer,
North Central Division

David Ross, Structural Engineer,
North Pacific Division

Stephen F. LeMaster, Structural Engineer,
Ohio River Division

James G. Lewis, Chief, Structural Section,
South Atlantic Division

James Tanouye and Robert Haavisto, Structural Engineers,
South Pacific Division

C. F. Berryhill, Chief, Structural Section,
Southwestern Division

The Conference was successful due to the efforts of a multitude of people. The roles they played were different but they were all directed toward making a concept on "instant dissemination" work. The

Organizing Committee for the Conference consisted of:

COL G. H. Hilt, WES

Mr. F. R. Brown, WES

Mr. D. L. Neumann, WES

Mr. J. B. Cheek, Jr., WES

Dr. N. Radhakrishnan, WES--Conference Coordinator

Mr. W. A. Price, WES

Mr. G. S. Hyde, WES

Mr. D. R. Dressler, LMVD

Mr. W. B. Dodd, LMNDE

Ms. E. Smith, LMNDE

Mr. L. H. Manson, LMNDE

An OCE Coordinating Committee also worked enthusiastically to ensure the success of the Conference. This Committee consisted of:

Mr. C. F. Corns

Mr. R. L. Delyea

Mr. R. F. Malm, OCE Coordinator

Mr. L. G. Guthrie

Mr. D. B. Baldwin

Mr. R. A. McMurrer

The New Orleans District did a remarkable job in playing hosts to the Conference.

There were 13 division speakers, 25 moderators, two invited speakers, four technical speakers, and ten session chairmen, who shared the technical load of the Conference. Also, eight computer vendors showed their wares to the participants.

The editor would like to thank all the individuals who served on the committees and the speakers and the moderators for sharing their time and thoughts. Without them the Conference would not have been the success it was. Mr. Donald Dressler, LMVD, and Mr. William Price, WES, are specially thanked for their technical guidance and assistance.

This report was edited by Dr. N. Radhakrishnan, Research Civil Engineer, Computer Analysis Branch (CAB) and Special Technical Assistant, ADP Center, under the direct supervision of Mr. J. B. Cheek, Jr., Chief,

CAB, and under the general supervision of Mr. D. L. Neumann, Chief, ADP Center.

The Director of WES during the Conference and the preparation of this report was COL G. H. Hilt, CE. Mr. F. R. Brown was Technical Director.

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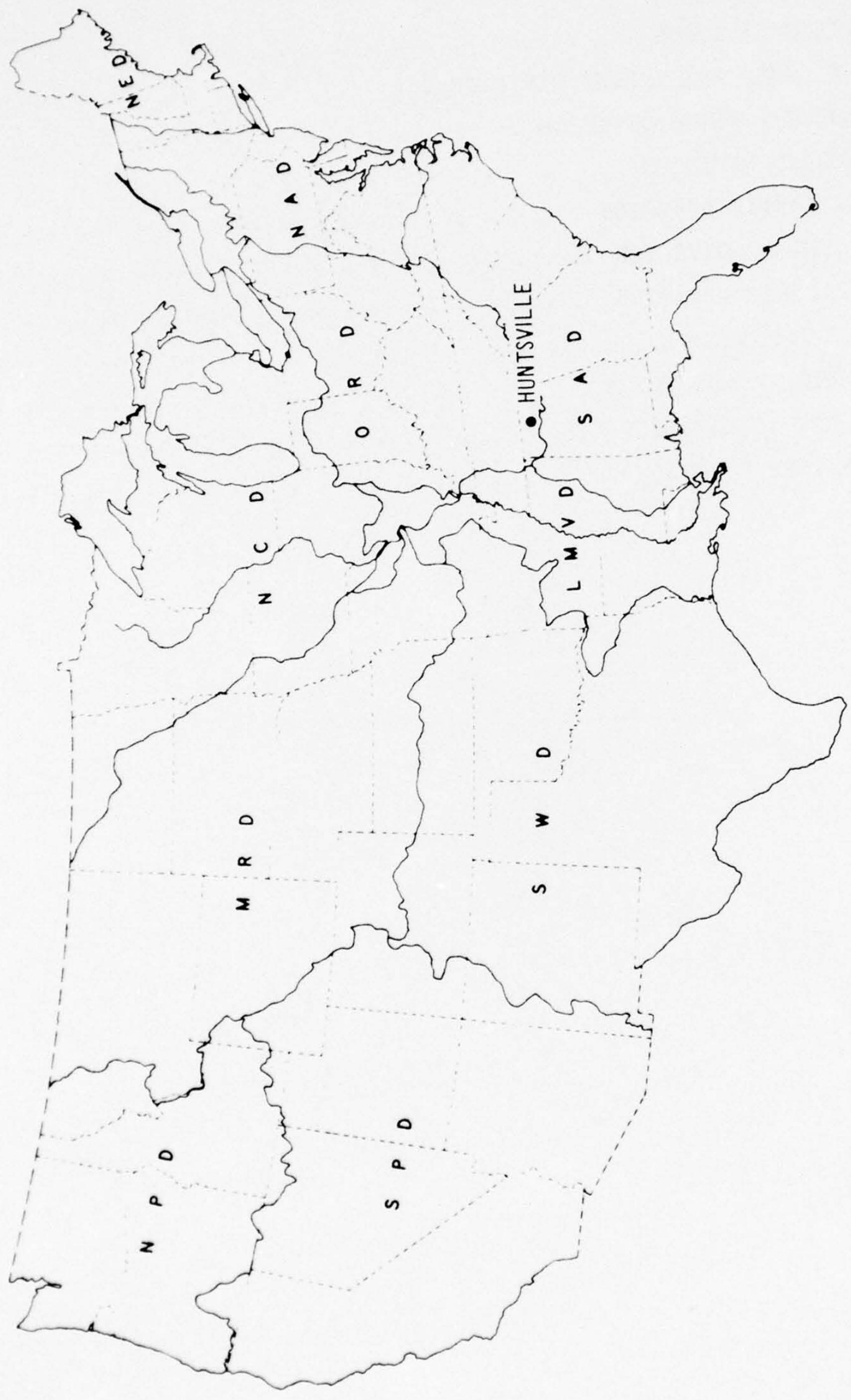
NED
NAD
ORD
HUNTSVILLE
SAD
NCD
LMVD
MRD
SWD
NPD
SPD

HUNTSVILLE DIVISION

by

Fred Bourgeois* and Robert M. Wamsley**

General Survey of Computer Use

The Huntsville Division (HND) is located in Huntsville, Alabama. HND differs from most other Corps of Engineers Divisions in that it has no District Offices and no public civil works mission. It is a relatively small organization with a few more than 300 employees.

HND was organized in 1967 to support the SAFEGUARD Systems Command in construction of Ballistic Missile Defense (BMD) sites, such as the one at Grand Forks, North Dakota. Since this site was intended to function in the event of a nuclear attack, it posed many formidable and interesting structural design and analysis problems. About 60% of this design and analysis was done by contract, with the HND Automatic Data Processing (ADP) Center providing computer processing support for both contractor and in-house structural applications. After the SALT agreements, construction of BMD sites, other than at Grand Forks, was abandoned. Construction has been completed on this, the only BMD site authorized by the Congress. However, research is being conducted for more advanced BMD facilities.

At present the major effort of the Huntsville Division is directed toward a program in support of the U. S. Army Materiel Command (AMC). This program is for the modernization and expansion of AMC's Munitions Production Base, a very extensive project covering a period of 13 years at a total cost of more than 6 billion dollars. Other roles include support for the Office, Chief of Engineers, and the Mediterranean Division through special studies related to the design of facilities and structures for protection against conventional weapons effects; support for the Mediterranean Division itself in design of military facilities

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* Mr. Fred Bourgeois is a computer specialist-mathematician with the Automatic Data Processing Center, Huntsville Division.

** Mr. R. M. Wamsley is a Group Leader, Dynamics and Computer Applications Group, Civil-Structures Branch, Huntsville Division.

in countries in the Middle East; support for the National Aeronautics and Space Administration in the design of specialized facilities, such as those for the Shuttle Program and those for rocket and propulsion research and production; and support for the Environmental Research and Development Agency (ERDA) in the development of systems for conversion of coal to other forms of energy.

The Huntsville Division is unlike other Division and District Offices in another respect--it does not have a computer--one of its own, that is. However, it does use computer facilities in Huntsville and in other cities around the country through batch, remote batch, and time-sharing terminals. Figure 1 illustrates the remote batch and

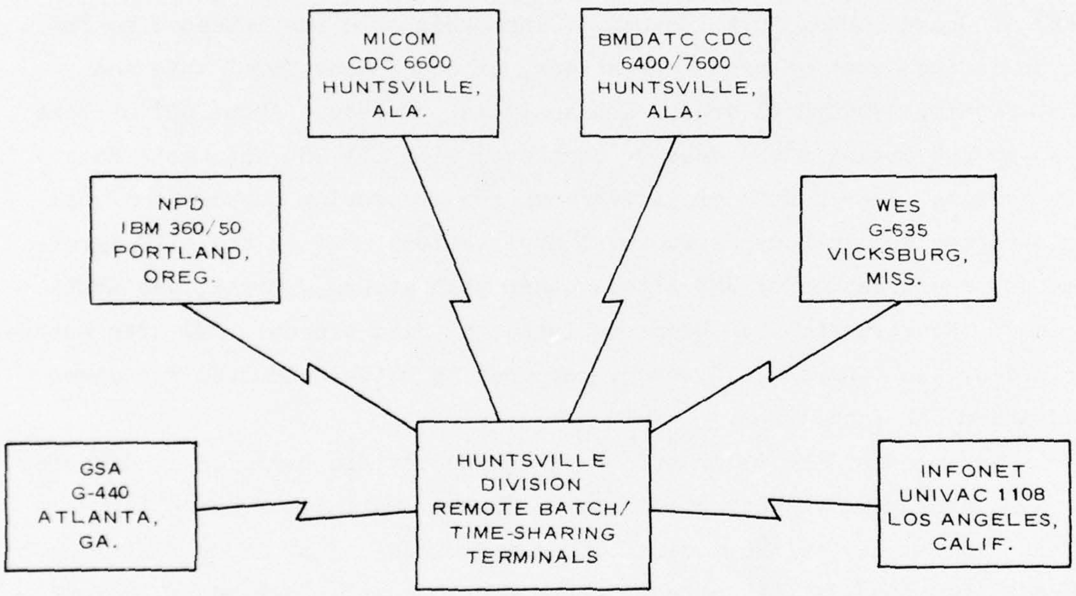


Figure 1. U. S. Army Engineer Division, Huntsville, remote computer processing capability

time-sharing capability. The biggest portion of the engineering computer workload is handled by the BMD Advanced Technology Center's CDC 6400/7600 system at a very reasonable cost--\$371 per system hour. The simple system hour cost algorithm provides an effective rate of about \$371 per central processor hour plus 1/4 cent per line printed at the central site. There is no charge for remote printing or for remote

connect time. The Army Missile Command's CDC 6600, located in Huntsville, carries much less of the Division's engineering workload.

Only in the last year or so has HND begun to use the time-sharing capability offered by the computer facilities at Vicksburg, Atlanta, Los Angeles, and Huntsville itself. Prior to that time all of the Division's computer processing requirements were handled in the batch or remote batch mode. But now, the time-sharing capability adds a whole new dimension to the HND engineer's potential for computer-aided problem solution. Only a fraction of this potential has been tapped thus far, but a few aggressive engineers are making a very good beginning at using time sharing, particularly for structural applications. The HND structural engineer relies on the various computer time-sharing system libraries for programs or routines to solve his engineering problems--e.g., GFRAME on the G-635, ANSYS on the INFONET UNIVAC 1108, and STRUDL on the North Pacific Division (NPD) IBM 360/50. When the need arises he writes his own time-sharing programs.

Time-sharing systems, of course, are used only for small applications, but some of the HND structural analysis and design projects involve large-scale dynamic problems. These problems are processed using the CDC 6400/7600 system with a set of programs developed under contract during the BMD site construction for general static and dynamic structural analysis, soil-structure interaction dynamic analysis, and shock isolation system design. One of these programs, General Elastic Nonlinear Structural Analysis Program (GENSAP), has been much used. GENSAP, actually a three-program system, is a 3-D dynamic finite element application which offers the engineer a very effective pre- and post-processing capability. SAP4, a more current, similar program, has recently been installed on the CDC 6400/7600 system. SAP4 provides a few additional, more sophisticated elements and also provides a more efficient eigenvalue extraction method; it lacks the pre- and post-processing capabilities of GENSAP. The HND ADP Center is presently working to add the preprocessing capability of GENSAP to SAP4.

HND has derived significant time and cost savings from the use of the CDC 7600 computer, a very powerful tool. It has the core memory,

the accuracy, the speed, and other qualities to make it very suitable for engineering and scientific applications, and especially so for finite element applications. Typical finite element applications previously processed by HND on a CDC 6400 computer required up to 30 hours of CP time. On the 7600 system the same problems can be processed in one-tenth the time and at one-third the cost.

The following tabulation compares the cost and speed of the CDC 7600 with that of the G-635 for a typical small finite element application processed on each of those systems. The programs used were both essentially the same, i.e., SAP4, but the G-635 version necessitated a double precision code for accuracy. As the tabulation shows, the 7600 processed the problem about 76 times faster at about 2% of the G-635 cost.

	Honeywell G-635	CDC 6400/7600
Degrees of freedom	384	384
Number of equations per block	42	185
Number of blocks	10	3
Computer CP time	1187.28 sec	15.5 sec
Cost	$81.65	$1.61
Turnaround time	24 hr	20 min

These data raise an important question: What is being planned to prepare the Corps of Engineers for future computer power? Dynamic finite element studies and models are getting bigger, more complex, and require more and more computer time. One is hearing more frequently about nonlinear or inelastic analysis. This particular application can require an enormous amount of computer time. One such study has recently been completed in Huntsville. This project was a dynamic soil-structure interaction analysis. Over a period of about nine months it consumed more than 36 hr of 7600 CP time. The equivalent time on a CDC 6400 would have been 360 hr, and if the problem could have been processed at all on the G-635, it might have required an unachievable amount of time.

The CDC 7600 is an extremely effective tool and the Corps of

Engineers would do well to acquire this kind of a system. Established as a central computer facility to serve the engineer Corps-wide, this system would certainly provide the computer power needed to process the evergrowing number of large dynamic finite element models, and other engineering applications as well. It is also important that the CDC 7600 would greatly reduce the many difficulties which prohibit the standardization of widely used programs.

Engineering Applications

The general aspects of computer usage in the Huntsville Division were presented by Mr. Bourgeois. Therefore, this presentation will emphasize engineering applications of computer-aided design programs.

First, a few remarks will be made which pertain to the general use of computer programs by engineers in the Huntsville Division. Then, two abbreviated examples will be presented. These examples are contained in Appendixes A and B.

Due to the changed mission of the Huntsville Division, engineering applications of computer programs have declined in recent months. However, the Dynamics and Computer Applications Group (1 to 3 engineers) in the Civil-Structures Branch actively uses and promotes computer methods for structural analysis. The following tabulation summarizes the duties and responsibilities of this group.

- Provides technical support to HND engineering
- Uses finite element programs to:

  (1) Design structures for:
  Static loads
  Pressure time histories (dynamic loads)
  Shock spectra

  (2) Analyze structures and equipment for:
  Static loads
  Pressure time histories (dynamic loads)
  Shock spectra

- Uses WES LIB Programs for quick response to routine problems
- Develops special purpose time-sharing programs for:

    Elastic and inelastic responses

    Frequencies and mode shapes

    Parametric studies for load/geometry/stress variations

The Engineering Mechanics Section of the Systems Engineering and Research Branch also uses computer programs for design and analysis on a regular basis.

Computer program needs and capabilities generally become recognized as a result of a specific requirement. The computer programs are used only when they are needed to provide adequate and timely response to the problem at hand. Occasionally, the analyst finds it advantageous to write his own time-sharing (FORTRAN) program to analyze, or evaluate, a particular problem.

The engineers (or analysts) who are primarily engaged in computer-aided design and analysis generally pursue their objectives with little direct supervision. They keep abreast of current developments in the field by reviewing technical and professional journals and by attending conferences and seminars. The attendance of courses and seminars devoted to computer analysis methods and techniques has always been supported by the Division.

Because there are so many different programs and computer systems in use, it is easy to understand the reluctance of many engineers to use computer programs to any significant degree. Thus, the question arises: To what extent should the typical engineer become familiar with and use computer-aided design techniques? Of course, there are several possible answers. One answer would be to have a computer analysis group to support, on a task basis, the various engineering disciplines. Another answer would be to have one or two computer analysis specialists in each discipline. The most inefficient answer would be to try to make every engineer equally proficient in computer-aided design techniques.

In any event, greater emphasis needs to be placed on the many beneficial aspects of computer usage. This conference is a significant step in the right direction.

Appendix A: Dynamic Analysis of Air Compressor

Sometimes a dynamic analysis becomes necessary, in lieu of testing, to verify the adequacy of a piece of equipment.

The following example is a dynamic analysis of an air-compressor unit which was installed in the Missile Site Radar Power Plant at the Grand Forks SAFEGUARD Site.

Figure A1 shows a layout drawing of the air-compressor unit. The functional elements include the belt wheel, the crankshaft assembly and housing, motor and bracket, base support, first and second tandems, low and high pressure cylinders, intercooler, dampener, and aftercooler. The air compressor is anchored with ten bolts to a concrete foundation.

The first step in the analysis was to obtain fabrication drawings and material properties for all the compressor components. The second step (Figure A2) consisted of establishing a mathematical model composed of beam elements. Node points were established wherever significant changes in geometry occurred. The geometric properties of the elements, such as area and moment of inertia with respect to local coordinates, were calculated.

The data above were then coded for the GENSAP, and mode shapes and frequencies (Figure A3) were extracted by the inverse iteration method.

Concurrent with the development of the model, an acceleration time history was obtained from the design shock spectra (Figure A4) using a waveform synthesis computer program (WAVSYN). Shock input data were generated for the X-Y plane, Y-Z plane, and a plane at 45 deg to the X-Y and Y-Z planes.

Then using GENSAP and the WAVSYN excitation functions, a dynamic analysis was performed by the normal mode method. Time histories for displacements and forces were obtained and evaluated. All of the compressor components including the anchor bolts (Figure A5) were determined to be satisfactory.

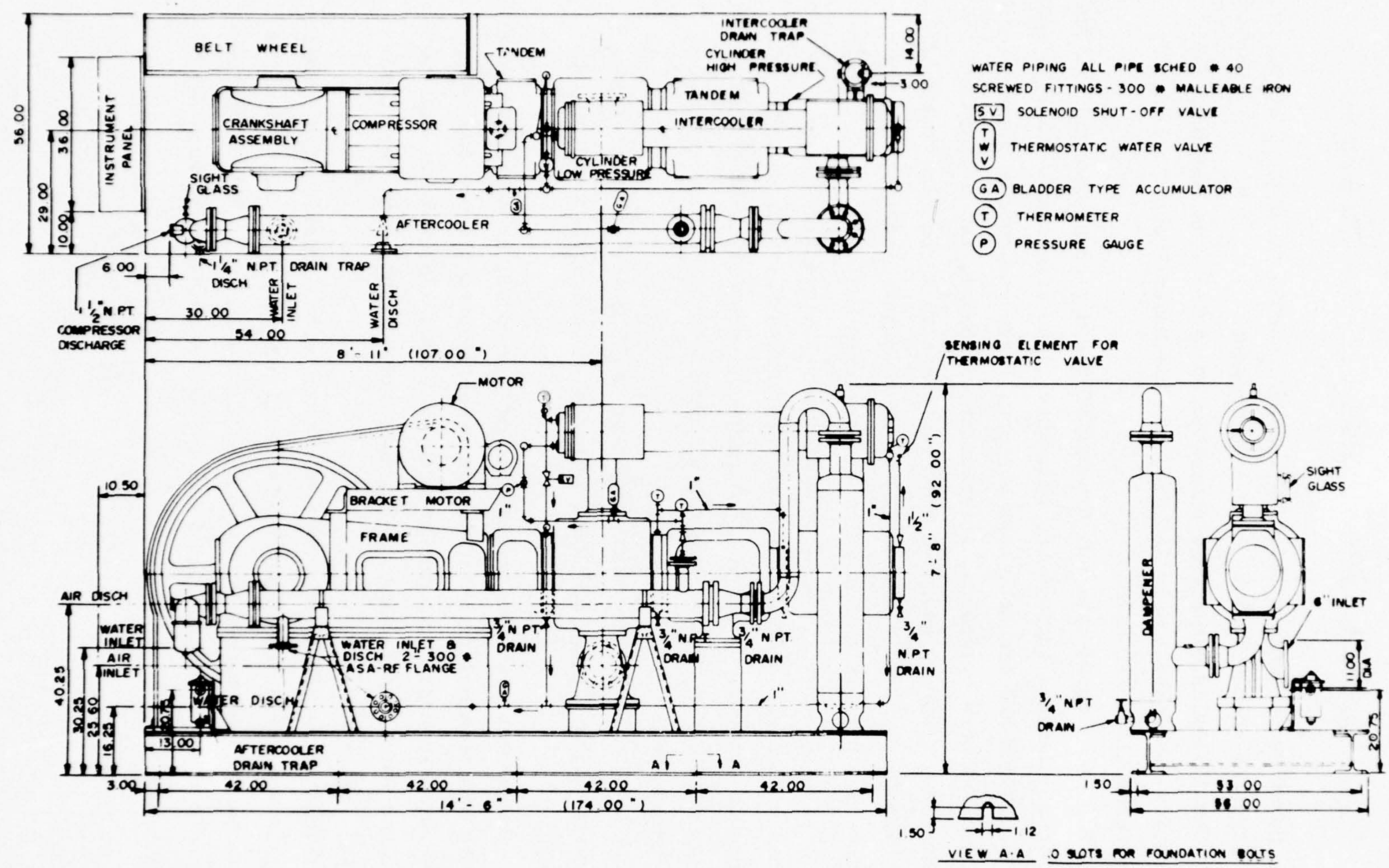


Figure A1. Layout Drawing - Air Compressor

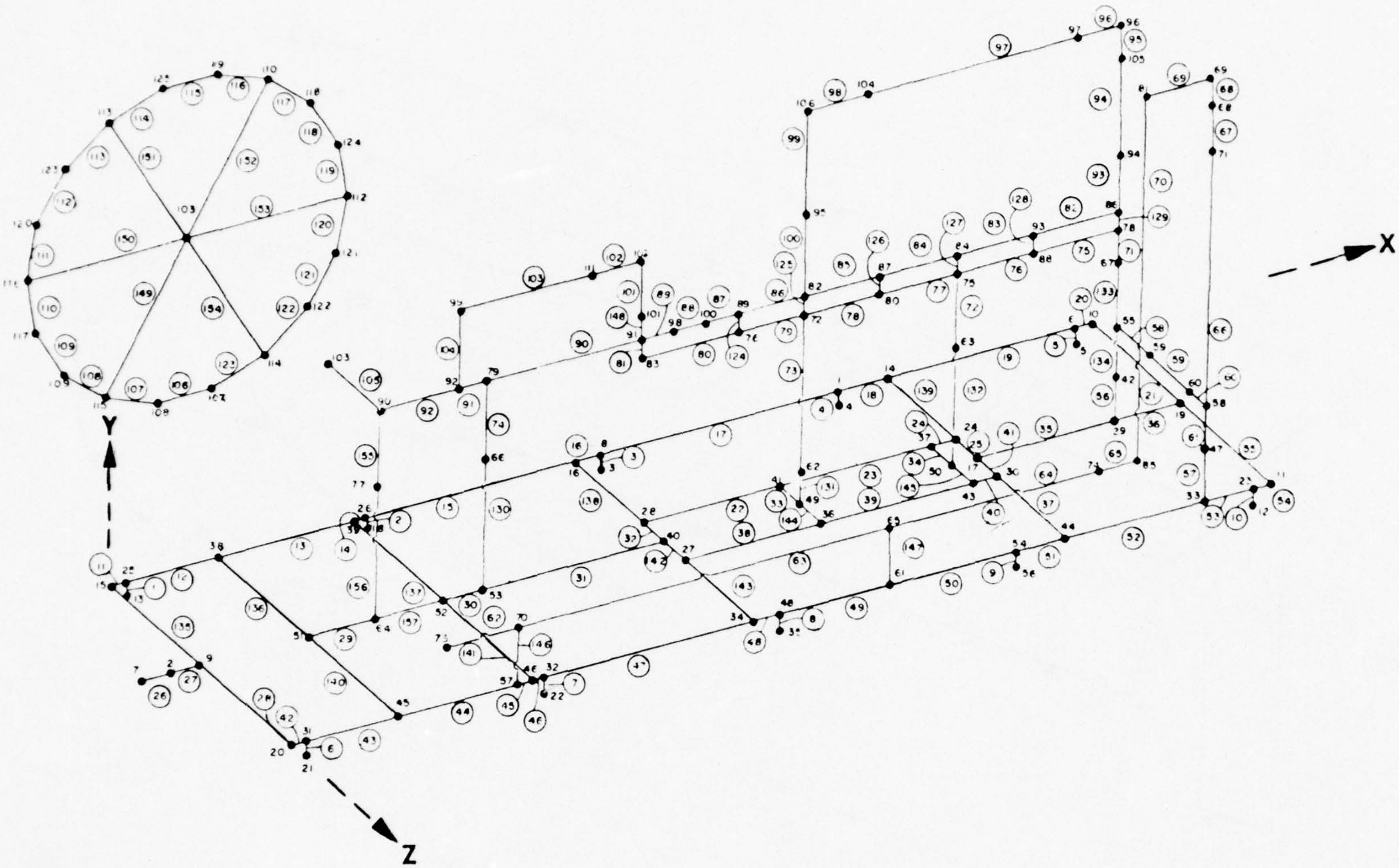


Figure A2. Mathematical Model - Air Compressor (P01CR)

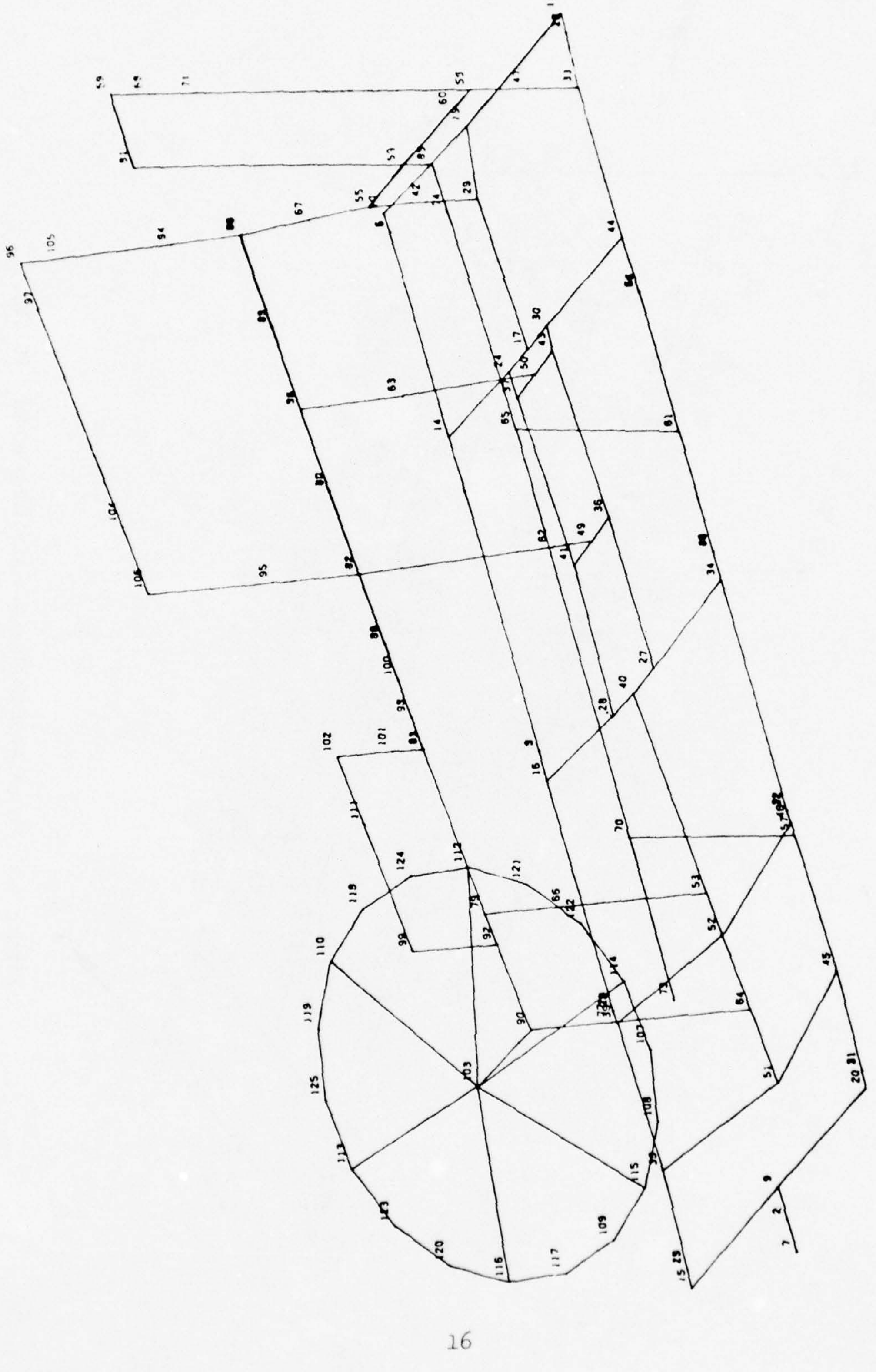


Figure A3. Mode 11

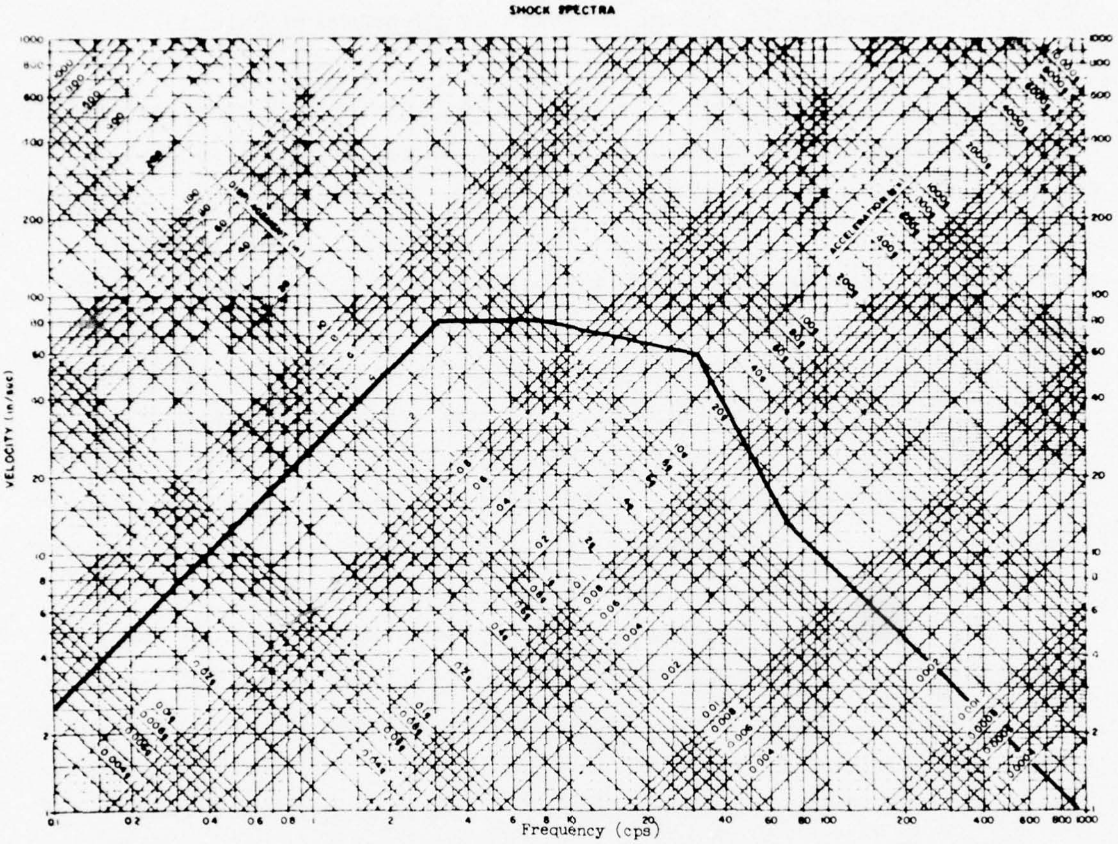


Figure A4. Envelope of vertical shock environment - 1st Floor MSRPP and 2nd Floor PARPP (Undamped)

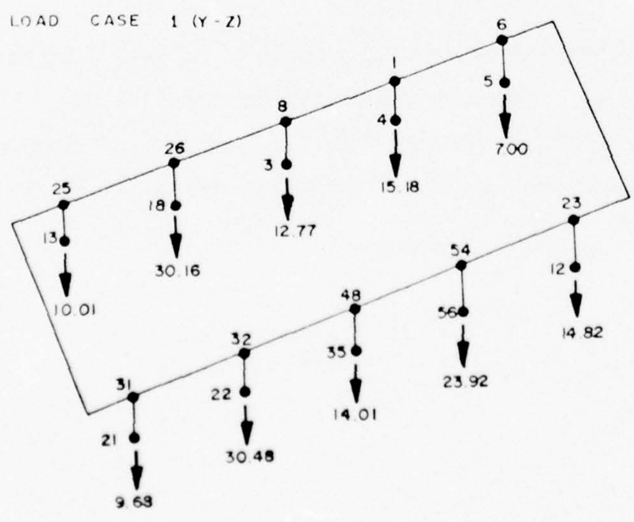


Figure A5. Summary of anchor bolt reactions (kips)

Appendix B: Design Analysis of Suppressive Shield

During the past year, the Huntsville Division has been responsible for the design and analysis of a 1/4-scale model suppressive shield, which is to be used in the Munitions Production Base Program. The purpose of the suppressive shield is to contain metal fragments and to attenuate the overpressures due to an accidental explosion during the manufacturing process.

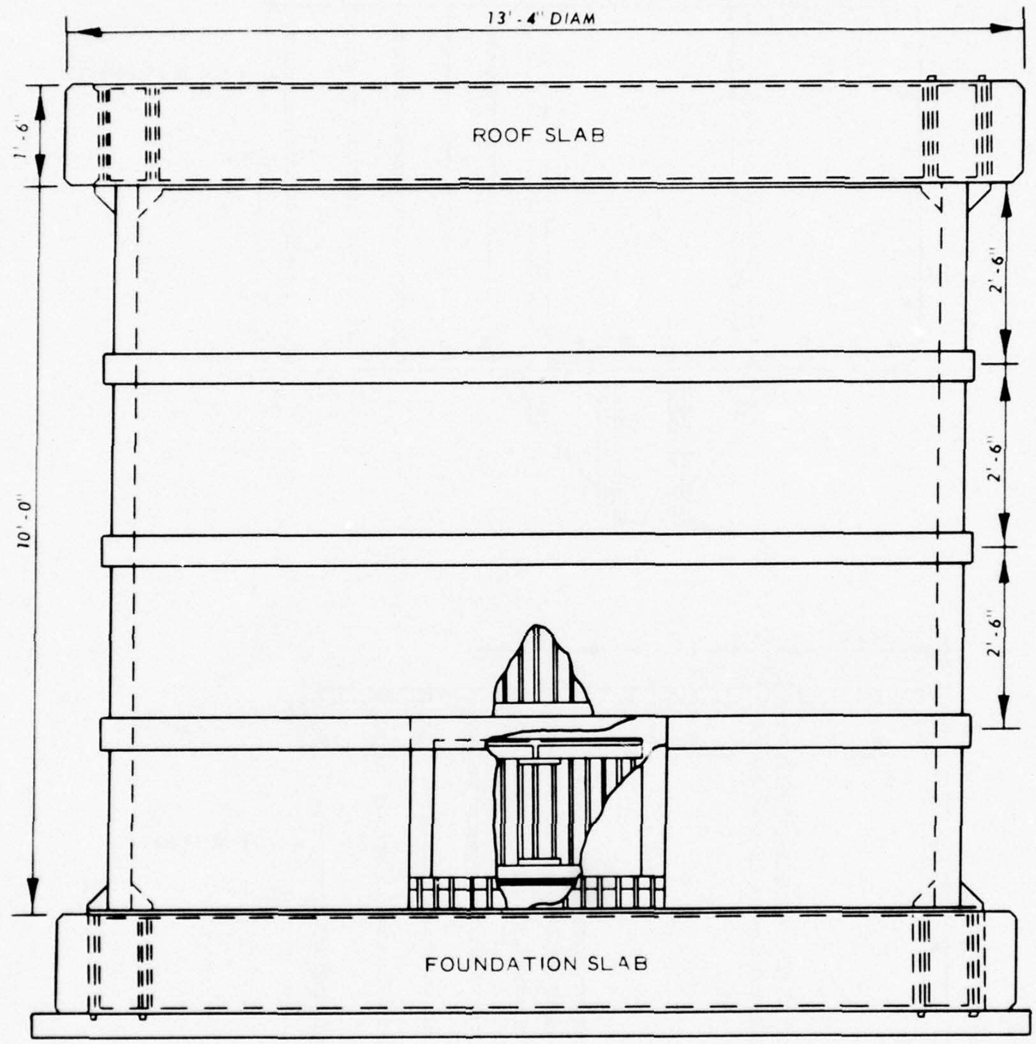
We studied several configurations prior to selecting the current concept, illustrated in Figure B1. The roof slab and the foundation slab are reinforced concrete; the remaining elements are structural steel. We performed a design analysis of the structure using a plane frame program and a two-degree elasto-plastic response program. A model of this structure has been built and successfully tested.

The information furnished to HND for the development of the first 1/4-scale model consisted of (a) general dimensions, (b) loads, and (c) column size and spacing. The items prepared by HND were (a) structural calculations, (b) engineering, fabrication, and erection drawings, (c) structural steel specifications, (d) concrete specifications, (e) steel fiber specifications, (f) instrumentation drawings, and (g) structural response predictions.

Figure B2 shows typical connection details at the roof and foundation slabs.

The Huntsville Division will continue to seek similar challenging applications for its computer-aided design capability.

A program entitled "Elasto-Plastic Response of Beams with Uniformly Distributed Load and Mass" is given below.



ELEVATION

(CATEGORY I, 1/4 SCALE MODEL)

Figure B1. Suppressive shield

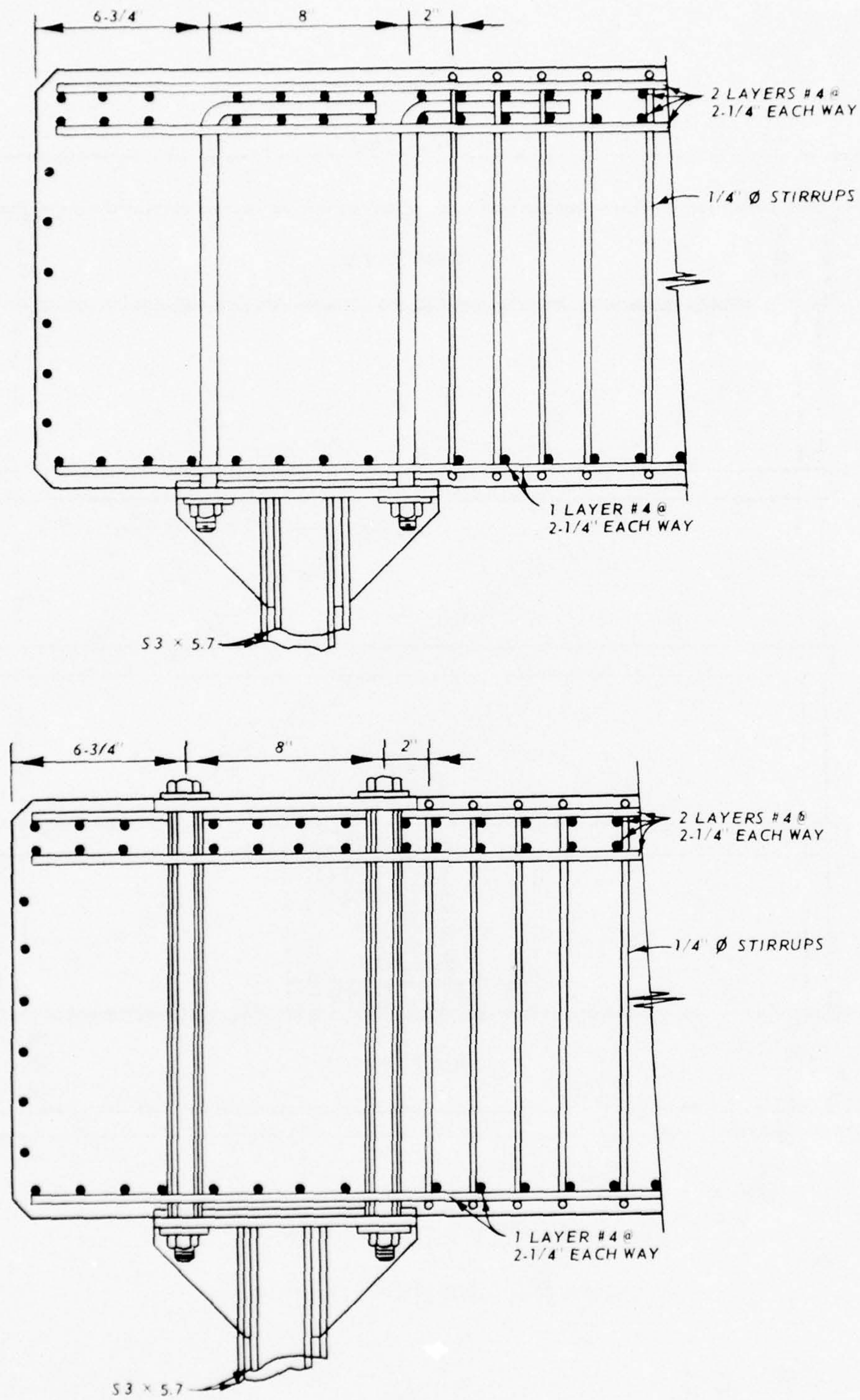


Figure B2. Typical section of suppressive shield

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OLD FILE? UTP2A
READY
*LIST

1000C PROGRAM REVISED 3-24-76
1100C UTP= ACRONYM FOR 'UTILITY PROGRAM'
1200C ELASTO-PLASTIC RESPONSE OF BEAMS WITH UNIFORMILY DISTRIBUTED
1300C LOAD AND MASS
1400C THIS PROGRAM CALCULATES RY, T, AND MU FOR BEAMS WITH A
1500C TWO TRIANGLE PRESSURE PULSE
1600C PM= LOAD (POUNDS PER LINEAR INCH OF BEAM)
1700C W= WEIGHT PER INCH OF BEAM
1800C XL = SPAN, INCHES
1900C XZ = PLASTIC SECTION MODULUS
2000C XI = MOMENT OF INERTIA ABOUT AXIS NORMAL TO PLANE OF BENDING
2100C FF= 1 FOR SIMPLY SUPPORTED BEAM, 2 FOR FIXED END BEAM
2200C U = MU,RATIO OF PLASTIC TO ELASTIC DEFLECTION
2300C T1 AND T2 ARE PULSE DURATIONS
2400C C1 AND C2 ARE PROPORTIONS OF PM
2500C C1+C2=1.0
2600C T= BEAM PERIOD
2700C RY= PLASTIC RESISTANCE, LB PER LIN INCH
2800C IREC = FIRST PULSE DURATION INDICATOR, 1= SHORT DUR.(IMPULSE)
2900C                                         2= LONG DURATION
3000C JREC = SECOND PULSE DURATION INDICATOR, 1 = SHORT DUR.(IMPULSE)
3100C                                         2 = LONG DURATION
3200C DEL= UPPER LIMIT OF RATIO TD/T FOR IMPULSE
330 PRINT," "
340 70 PRINT,"ENTER PM,C1,C2,T1,T2"
350 PRINT, " "
360 READ,PM,C1,C2,T1,T2
370 IF (PM) 300,300,85
380 5 CONTINUE
390 85 PRINT,"DO YOU WANT PROGRAM TO CALCULATE T AND RY?"
400 PRINT,"ENTER 1 FOR YES, 0 FOR NO"
410 PRINT," "
420 READ,Y
430 IF(Y .EQ. 0) GO TO 75
440 PRINT," "
450 10 CONTINUE
460 PRINT,"ENTER 1 FOR SIMPLY SUPPORTED, 2 FOR FIXED ENDS"
470 PRINT," "
480 READ,FF
490 IF (FF)290,290,20
500 20 PRINT,"ENTER W,XI,XZ,XL,FDY,EMOD"
510 PRINT," "
520 READ,W,XI,XZ,XL,FDY,EMOD
530 E = EMOD
540 IF (FF) 290,290,25
550 25 IF(FF .EQ. 1) GO TO 30
560 15 RY=16*FDY*XZ/(XL*XL)
570 A=0.78*W*(XL**4)
580 B=307.*E*XI
590 C=(A/B)**0.5
600 T=0.32*C
610 GO TO 50
620 30 RY= 8*FDY*XZ/(XL*XL)
```

```
AA=(E*XI*386./W)**0.5
BB=2.0*(XL**2.)/3.1416
T=BB/AA
50 PRINT,"RY=",RY
PRINT,"T=",T
PRINT,"  "
U=0
GO TO 80
40 CONTINUE
75 PRINT,"ENTER T,MU,RY"
PRINT,"  "
READ,T,U,RY
C
IF (T) 70,70,80
80 A1=T1/T
PRINT,"T1/T=",A1
      A2 = T2 / T
PRINT,"T2/T=",A2
      X1 = C1 * PM / RY
      X2 = C2 * PM / RY
      Z = 3.1416
IF(U)100,100,220
100 U=1.0
C TEST FOR SHORT DURATION (TD/T LESS THAN 0.2)
110 IF(A1-0.2) 120,130,130
120 B1=(2.0*U-1.0)**0.5
      B2 = T / (Z * T1)
      F1 = B1 * B2
IREC=1
      GO TO 140
130 F1=T/(Z*T1)*(2.0*U-1.0)**0.5
F1= F1+(1.0-1.0/(2.0*U))/(1.0+0.7*T/T1)
IREC=2
140 IF(A2-0.2) 150,160,160
150 F2=(2.0*U-1.0)**0.5*(T/(Z*T2))
JREC=1
      GO TO 170
160 F2=T/(Z*T2)*(2.0*U-1.0)**0.5
F2=F2+(1.0-1.0/(2.0*U))/(1.0+0.7*T/T2)
JREC=2
IF(IREC .EQ. 2) GO TO 170
IF(JREC .EQ. 2) GO TO 172
FAC1= X1/F1
FAC2= X2/F2
GO TO 175
172 FAC1=(X1/F1)**2.
     FAC2=X2/F2
GO TO 175
 170 FAC1 = X1 / F1
       FAC2 = X2 / F2
175 SUM=FAC1 + FAC2
       IF (SUM - 1.0) 190, 190, 180
180 U = U +0.025
       GO TO 110
190 PRINT,"IREC=",IREC
PRINT,"JREC=",JREC
PRINT,"F1=", F1
```

```
1200 PRINT,"F2=",F2
1210 PRINT 200
1220  200 FORMAT (6X, "C1PM/RY/F1", 9X, "C2PM/RY/F2",
1230&       8X, "SUM", 18X, "MU")
1240 PRINT 210,FAC1,FAC2,SUM,U
1250 210 FORMAT(4(6X,F10.4))
1260 U=0.
1270 PRINT,"  "
1280 IF(FF) 75,75,10
1290C TEST FOR SHORT DURATION (TD/T LESS THAN 0.2)
1300 220 IF(A1-0.2) 230,240,240
1310 230 F1 = (2.0 * U-1.0)** 0.5 * T/(Z*T1)
1320 IREC=1
1330       GO TO 250
1340 240 F1 = T / (Z * T1) * (2.0 * U - 1.0)**0.5
1350 F1 = F1 + (1.0 - 1.0/(2.0 * U)) / (1.0 + 0.7 * T / T1)
1360 IREC=2
1370 250 IF(A2-0.2) 260,270,270
1380 260 F2= (2.0 * U - 1.0)**0.5 * T / (Z * T2)
1390 JREC=1
1400       GO TO 280
1410 270 F2 = T / (Z * T2) * (2.0 * U - 1.0)**0.5
1420 F2 = F2 + (1.0 - 1.0/(2.0 * U)) / (1.0 + 0.7 * T / T2)
1430 JREC=2
1440 280 IF(IREC .EQ. 2) GO TO 281
1450 IF(JREC .EQ. 2) GO TO 282
1460 V1=C1*PM/F1
1470 V2=C2*PM/F2
1480 RY= V1+V2
1490 GO TO 285
1500 282 V1=(C1*PM/F1)**2.
1510       V2= C2*PM/F2
1520 RY=V2/2. +SQRT(V1*V1+V2*V2/4.)
1530 GO TO 285
1540 281 V1=C1*PM/F1
1550       V2=C2*PM/F2
1560 RY=V1+V2
1570 285 PRINT,"IREC=",IREC
1580 PRINT,"JREC=",JREC
1590 PRINT,"F1=",F1
1600 PRINT,"F2=",F2
1610 PRINT," "
1620       PRINT, "RY= ", V1, " + ", V2, " = ", RY
1630 PRINT,"  "
1640 GO TO 40
1650 290 GO TO 70
1660 300 STOP
1670       END

ENTER PM,C1,C2,T1,T2

=6990,0.95,0.05,0.0003,1.0
DO YOU WANT PROGRAM TO CALCULATE T AND RY?
ENTER 1 FOR YES, 0 FOR NO

=1
```

```
ENTER 1 FOR SIMPLY SUPPORTED, 2 FOR FIXED ENDS

=2
ENTER W,XI,XZ,XL,FDY,EMOD

=.475,2.52,1.95,36,42000,29000000
RY=  0.10111111E 04
T=  0.16853133E-02

T1/T=  0.17800845E 00
T2/T=  0.59336150E 03
IREC=                 1
JREC=                 2
F1=  0.82236297E 01
F2=  0.95619520E 00
     C1PM/RY/F1          C2PM/RY/F2        SUM                MU
         0.6378              0.3615        0.9993          11.0750

ENTER 1 FOR SIMPLY SUPPORTED, 2 FOR FIXED ENDS

=0
ENTER PM,C1,C2,T1,T2

=0
=0,0,0,0

*BYE
```

Appendix C: Abstracts of Huntsville Division Structural Engineering Computer Programs

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM INSLAB	PROGRAM NO. 713-C8-70-13

PREPARING AGENCY
U.S. Army Engineer Division, Huntsville, Huntsville, AL 35807

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STATUS OF PROGRAM: STAGE
Agbabian Associates Los Angeles, CA	September 1970	Init	OP

A. PURPOSE OF PROGRAM

INSLAB is a program for the dynamic analysis of bending and transverse shear deformations in thin and moderately thick inelastic plates. The plate can be of arbitrary shape and can have beam or column supports, concentrated masses, and interior holes at arbitrary location. Transverse pressure loadings along the surface and rigid body motions of the boundaries comprise input excitation.

B. PROGRAM SPECIFICATIONS

The program is written in FORTRAN IV. The present version of the program is limited to models with maximum of 90 elements, 100 node points, 50 columns, and others.

C. METHODS

INSLAB is a finite element code using a step-by-step integration procedure and bilinear material properties. The finite element used in the linear curvature compatible triangule derived by Clough and Felippa. The basic plate mesh unit is the Q-19 quadrilateral. Single triangules and prismatic beam elements may also be used.

D. EQUIPMENT DETAILS

The program is presently operational on CDC 6000 series computer systems.

E. INPUT-OUTPUT

Input: Node point and element data define geometry of model; material properties; loading and excitation time histories. Output: Echo print of input; relative motions are computed and printed; nodal forces including reactions; element internal forces.

F. ADDITIONAL REMARKS

Additional documentation is available.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM	PROGRAM NO.
FEDIA	713-C8-70-15

PREPARING AGENCY
U.S. Army Engineer Division, Huntsville, Huntsville, AL 35807

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STATUS OF PROGRAM: STAGE
Agbabian Associates Los Angeles, CA	May 1973	Init	OP

A. PURPOSE OF PROGRAM

FEDIA is a dynamic, inelastic, 2-D, continuum finite element computer code. It may be used to solve dynamic, inelastic axisymmetric or plane strain problems.

B. PROGRAM SPECIFICATIONS

The code is written in standard ASA FORTRAN IV and the program dynamically allocates core storage for the data used in the calculations. The data is blocked so as to allow arithmetic operations on one block of data at a time while the other blocks reside on peripherals such as disc. The program has a self-contained restart capability.

C. METHODS

The 2 global axes are referred to as r and z. The type of finite element used is an axisymmetric quadrilateral which can be used as a plain strain quad by setting an input value to a very large number. Inelastic material properties are represented by nonlinear, hysteretic bulk and shear moduli, by perfectly plastic yield criteria and the plastic potential flow rule. Small strains are assumed.

D. EQUIPMENT DETAILS

The program is presently running on a CDC 6400/7600 system with 7600 small core memory (SCM) of 64K and large core memory (LCM) of 512K. It uses only 45_8K of SCM and up to 130_8K of LCM. The program uses 13 FORTRAN logical units in addition to the standard input, output units.

E. INPUT-OUTPUT

Input: Nodal point data, element data, material properties. Output: Echo print of input; displacements, velocities, accelerations of each nodal point; stresses and strains in each element. Stress and motion time history plots can be obtained using a companion program HPLØT.

F. ADDITIONAL REMARKS

Boundary Conditions: One pressure-time history having various arrival times at selected nodal points; one of several velocity-time histories applied to selected nodal points; boundary free or boundary fixed along either global axis; energy-absorbing boundary along either global axis. Detailed documentation is available.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM SLAB	PROGRAM NO. 713-C8-70-06
PREPARING AGENCY U.S. Army Engineer Division, Huntsville, Huntsville, AL 35807	

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STATUS OF PROGRAM: STAGE
Agbabian Associates	April 1972	Init	OP

A. PURPOSE OF PROGRAM

SLAB is actually a system of 3 programs (including pre and post-processor) for large finite element modeling in the elastodynamic analysis of thin and moderately thick flat plates of arbitrary shape. The plate may have concentrated masses, beams, column, and cut-outs or holes at arbitrary locations along the surface of the plate. Isotropic or orthotropic material properties can be specified, and may vary for different regions of the plate.

B. PROGRAM SPECIFICATIONS

The programs are written in ASA FORTRAN IV. The programs dynamically allocate core for storing large arrays and matrices and make use of a maximum of 11 FORTRAN logical units in addition to standard input and output units. The programs also have a self-contained restart capability.

C. METHODS

Three types of elements are available: Quadrilateral, triangular, and beam. Quadrilateral and triangular elements are completely compatible. The assumptions in the program are in accordance with Timoshenko's standard plate bending theory with Kirchoff's shear deformation model included. As a rule the ratio of deflection to thickness must be less than .5 and that of length to thickness should be greater than 10. for these assumptions.

D. EQUIPMENT DETAILS

The program is presently coded for a CDC 6400/7600 system.

E. INPUT-OUTPUT

Input: Node point data, element data define geometry of model. Material properties are specified by the user. Input loading may consist of ground motion acceleration and/or force time histories. Output: An echo point of input; new, renumbered mesh, if this option is activated; a plot of mesh; print of eigenvalues and eigenvectors; point of relative motion data, internal moments and shears, reactive moments and forces; contour plots for specified quantities; printout and/or plots of absolute motion; shock spectra.

F. ADDITIONAL REMARKS

Detailed documentation is available.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM Dynamic, Elastic, Plane Strain/Stress (DEPS)	PROGRAM NO. 713-C8-70-06C

PREPARING AGENCY
U.S. Army Engineer Division, Huntsville, Huntsville, AL 35807

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STAGE
Agbabian Associates, 250 North Nash Street, El Segundo, California 90245. Code has been used extensively by the Huntsville Division.	June 1973		

A. PURPOSE OF PROGRAM

This system offers the solution of ANY dynamic, elastic, plane strain, plane stress, or axisymmetrical problems that can be adequately approximated by an assemblage of quadrilateral, triangular, and one-dimensional finite elements.

B. PROGRAM SPECIFICATIONS

The system is comprised of three separate computer codes, PREDPS, DEPS, and DPSOUT, each code having a stand-alone capability. The codes are written in FORTRAN IV and can be readily adapted to suit any computer capable of running FORTRAN IV. However, the capacity and efficiency of the programs is greatly enhanced through the use of large-scale machines.

C. METHODS

This system applies finite element techniques to the solution of a wide variety of engineering problems. Significant references include the following: (1) Wilson, E. L., "Elastic Dynamic Response of Axisymmetric Structures," Structural Engineering Laboratory Report No. 69-2, University of California, Berkeley, January 1969. (2) Clough, R. W., "Analysis of Structural Vibrations and Dynamic Response," Proc., Japan-U.S. Seminar on Matrix Methods of Structural Analysis and Design, Tokyo, Japan, August 1969.

D. EQUIPMENT DETAILS

The configuration required for this version of the current system includes a CDC 6400 mainframe, card reader, line printer, on-line mass storage (capable of nine logical assignments), two magnetic tape drives, and a plotter.

E. INPUT-OUTPUT

Input to PREDPS is via the card reader and includes such things as a description of the finite mesh model, pressure histories, velocity histories, loads, material properties, etc. Output from PREDPS includes printouts of the input data, the new renumbered mesh (if desired), and requested eigenvectors; plots of the original mesh and eigenvector plots; and restart tapes. Input to DEPS is via magnetic tape (from PREDPS) and the card reader. Output from DEPS includes printouts of the displacements, velocities, accelerations, and stresses; restart tapes, and a tape of saved time history data for DPSOUT. Input to DPSOUT is via magnetic tape (from DEPS) and the card reader. Output from DPSOUT includes listings of time histories, plots of time histories, and punched cards containing amplitudes of specified time histories.

F. ADDITIONAL REMARKS

These codes have been successfully executed on Univac 1108 and CDC/6600-6400 computers.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM: SHOCK ISOLATION DESIGN FOR SAFEGUARD TSE SYSTEMS & EQUIPMENT	PROGRAM NO.: 713-C8-70-05S
PREPARING AGENCY: U.S. Army Engineer Division, Huntsville, P.O. Box 1600 West Station, Huntsville, AL 35807	

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STAGE
See below*	August 1973		

A. PURPOSE OF PROGRAM

The purpose of this system is to provide performance objectives and standard design and design verification methods for the installation of shock isolation systems.

B. PROGRAM SPECIFICATIONS

This system is composed of thirteen computer programs which are integrated into two computer packages, ISIP and ISIP2. A user can execute, through ISIP, any or all of the subprograms with an option to skip or terminate the computation process at the end of any subprogram. Similarly, a user can execute any or all of the ISIP2 subprograms.

C. METHODS

ISIP was developed to make shock analysis of a rigid platform a continuous process, with minimum input repetition. Computer programs ISOLIN, WAVSYN, ISOL, NWVSYN, SYNSOL, PLTSUB, SPCTRM, FILTER and FOURIE were incorporated into ISIP as subprograms. ISIP2 was developed to solve the shock response of a non-rigid platform based on the finite element technique and modal analysis. ISIP2 contains two subprograms, PLTFRM and FVOUS. An overlay programming technique is employed by both ISIP and ISIP2 to eliminate huge computer core requirements.

D. EQUIPMENT DETAILS

The configuration required for this version of the current system includes a 6400 mainframe, card reader, line printer, on-line mass storage (capable of six logical assignments), one magnetic tape drive and a plotter.

E. INPUT-OUTPUT

Input to the system is via the card reader and includes such things as engineering data of the platform, dimensions, configurations, weights, platform design resonant frequency, and the design critical damping ratio used to compute the spring/damper constants for a level platform. Output includes printouts of the input data, generalized shock spectrum for damped and undamped vibrations, acceleration, time and frequency tables, rigid and non-rigid platform analysis, and either line printer or CALCOMP plots.

F. ADDITIONAL REMARKS

These codes have been successfully executed on a UNIVAC 1108 computer system with a word-core space of 32,000 (decimal) and on a CDC 6400 computer system with 76,000 (octal) words.

*This system is a consolidation of several previous studies on shock isolation design analysis under the direction of the Huntsville Division, Corps of Engineers. Much of the information in Part I and Part II of the Shock Isolation Design Manual is extracted from "Development of Standard Design Specifications and Techniques for Shock Isolation Systems," Vols I, II, and III (SAF-37) prepared by the Ralph M. Parsons Company. The material in Part III and Part IV is based on a report (SP-232-0594) prepared by the Space Support Division of Sperry Rand Corporation, Huntsville, Alabama.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM General Elastic and Nonlinear Structural Analysis Program (GENSAP)	**PROGRAM NO.** 713-C8-70-06F
PREPARING AGENCY U.S. Army Engineer Division, Huntsville, Huntsville, AL 35807	

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STATUS OF PROGRAM: STAGE
Agbabian Associates, 250 North Nash Street, El Segundo, CA 90245. Code has been used extensively by the Huntsville Division.	June 1973		

A. PURPOSE OF PROGRAM

GENSAP is a general purpose system for three-dimensional analysis of structural systems using the finite element approach.

B. PROGRAM SPECIFICATIONS

The system is comprised of three separate computer codes, PRESAP, RSPNSE, and SAPOUT, each code having a stand-alone capability. The codes are written in FORTRAN IV and can be readily adapted to suit any computer capable of running FORTRAN IV. However, the capacity and efficiency of the programs is greatly enhanced through the use of large-scale machines.

C. METHODS

The PRESAP and RSPNSE codes are based on the SAP (Structural Analysis Program) which was developed in 1969 and 1970 by Professor E. L. Wilson, University of California, Berkeley. Significant features are modal extraction by an approximate Rayleigh-Ritz method and linear/nonlinear analyses by the step-by-step integration method.

D. EQUIPMENT DETAILS

The configuration required for this version of the current system includes a CDC 6400 mainframe, card reader, line printer, on-line mass storage (capable of ten logical assignments), two magnetic tape drives, and a plotter.

E. INPUT-OUTPUT

Input to PRESAP is via the card reader and includes such things as a description of the finite mesh model, loads, material properties, etc. Output from PRESAP includes printouts of the input data, the new renumbered mesh (if desired), and requested mode shapes and frequencies; plots of the original and new mesh and eigenvector plots; and restart tapes. Input to RSPNSE is via magnetic tape (from PRESAP) and punched card (for dynamic loading). Output from RSPNSE includes, among other things, printouts of displacements, rotations, time histories, stresses, restart tapes, and a tape of saved time history data for SAPOUT. Input to SAPOUT is via magnetic tape (from RSPNSE) and the card reader. Output from SAPOUT includes listings and plots of motion and stress time histories, punched cards, and plots of response shock spectra.

F. ADDITIONAL REMARKS

These codes have been successfully executed on Univac 1108 and CDC/6600-6400 computers.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM: AN IMPROVED COMPUTER PROGRAM TO CALCULATE THE AVERAGE BLAST IMPULSE LOADS ACTING ON A WALL OF A CUBICLE	PROGRAM NO.: None
PREPARING AGENCY: Picatinny Arsenal, Dover, New Jersey	
AUTHOR(S): Stuart Levy	DATE PROGRAM COMPLETED: May 1970
STATUS OF PROGRAM: PHASE:	STAGE:

A. PURPOSE OF PROGRAM

To calculate the average blast impulse loads acting on a wall of a cubicle when an explosive charge is detonated within the cubicle.

B. PROGRAM SPECIFICATIONS

FORTRAN IV

C. METHODS

It was devised by the Ammunition Engineering Directorate's Processing Engineering Laboratory in connection with the Safety Design Criteria Program and it simplifies an earlier computer program used to calculate data points for the construction of impulse charts in Technical Manual 5-1300, "Structures to Prevent the Effects of Accidental Explosion."

D. EQUIPMENT DETAILS

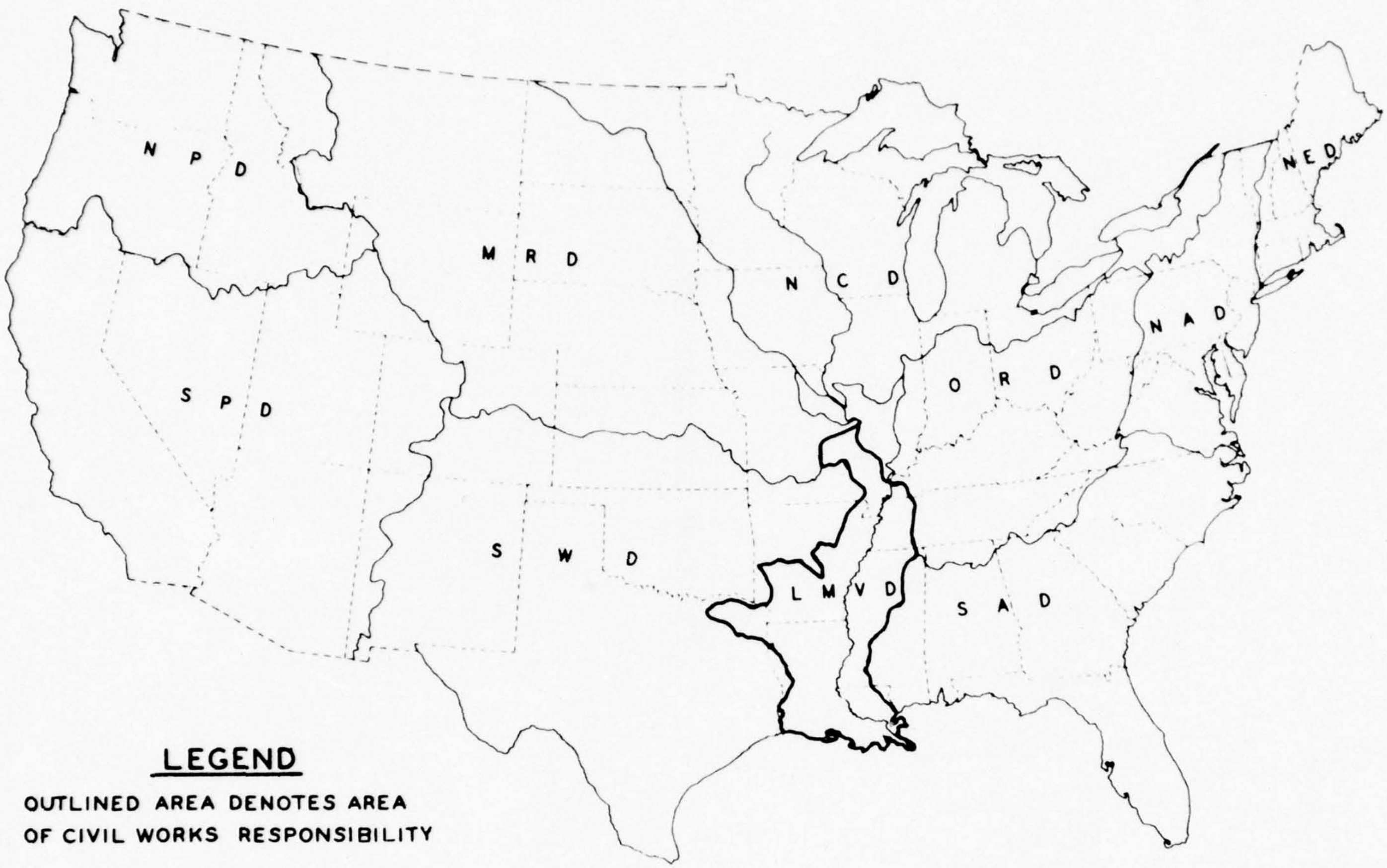
IBM 360 (originally) CARD
Has been revised to run on CDC 6000 TSS & BATCH
CDC 7000 TSS & BATCH
Honeywell G-635 TSS & BATCH
Honeywell G-437 BATCH only

E. INPUT-OUTPUT

F. ADDITIONAL REMARKS

Documentation is available from Picatinny Arsenal, U.S. Army Munitions Command, Dover, New Jersey, telephone AC 201-328-6522.

LOWER MISSISSIPPI VALLEY DIVISION



LEGEND

OUTLINED AREA DENOTES AREA
OF CIVIL WORKS RESPONSIBILITY

LOWER MISSISSIPPI VALLEY DIVISION

by

Donald Dressler*

Preface

Since this report summarizes the state of computer-aided structural engineering in the Lower Mississippi Valley Division (LMVD), it is impossible to mention everyone whose experience and knowledge have contributed to the information contained herein. The author gratefully acknowledges the assistance of the following people who reviewed a draft of this paper and provided many valuable comments.

LMVD/MRC	WES Computer Analysis Branch	New Orleans District
R. I. Kaufman	J. B. Cheek	W. D. Judlin
R. C. Armstrong	N. Radhakrishnan	L. H. Manson
W. R. Hill	W. A. Price	J. G. Bigham
R. J. Dubisson	L. M. Lipscomb	C. W. Ruckstuhl
V. M. Agostinelli		
R. Y. Lamere		

St. Louis District	Vicksburg District	Memphis District
B. R. Hughey	J. R. Melton	S. I. Kaufman
T. J. Mudd	C. M. Hargett	R. E. Brittain
J. J. Smith	T. C. Cox	
C. L. Smith	W. T. Miller	
J. P. Hartman		
J. W. Eckles		

MG Francis P. Koish was President, Mississippi River Commission (MRC), and Division Engineer, and Mr. Rodney H. Resta was Chief, Engineering Division, during the preparation of this report.

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* Structural Engineer, Lower Mississippi Valley Division.

Introduction

The LMVD/MRC is located in Vicksburg, Mississippi. This dual agency directs the work of the St. Louis, Memphis, Vicksburg, and New Orleans Districts. These offices are exclusively engaged in a Civil Works Program. Our FY 75 budget was approximately 400 million dollars of which 70 percent was for construction of new projects.

Our projects are located in parts of seven states (i.e. Missouri, Illinois, Arkansas, Tennessee, Mississippi, Texas, and Louisiana). However, most of the water from a major flood comes from areas beyond our jurisdiction. The primary responsibility of our offices is to safely convey the drainage from 41 percent of the area in the 48 contiguous states down the Mississippi River to the Gulf of Mexico.

Much of the work in the Memphis, Vicksburg, and New Orleans Districts is authorized under the Flood Control Act of 1928. This Congressional act created the Mississippi River and Tributaries Project which lies within the shaded area shown in Figure 1. This work is performed under the direction of the MRC. The remainder of the projects in these three districts and all of the projects in the St. Louis District are directed by the LMVD.

A summary of the major structures in the LMVD/MRC includes:

a. Inland waterways. Twelve locks and eight dams are in operation and eight others are being designed.

b. Coastal waterways. Eight locks are in operation, two replacement studies are being considered, and there are numerous floodgates and control structures in the New Orleans District.

c. Floodway control structures. There are two such structures in operation on the Mississippi River.

d. Multipurpose reservoirs. There are thirteen projects in operation, two are being designed, and two are under construction.

e. Pump stations. The Memphis District is constructing the Huxtable Pump Station (12,000 cfs) and the Vicksburg District is designing the Lake Chicot (6,500 cfs) and Tensas-Cocodrie (4,500 cfs) stations.

f. Flood protection. The St. Louis Project was completed in

Figure 1. Mississippi River and tributaries

1974. It included 7 miles of floodwall, 28 pump stations, and 44 major sewer alterations.

g. Hurricane protection. The Lake Pontchartrain Project began construction in 1967. The structural features include miles of floodwall, a pump station, four floodgates, three control structures, and two locks.

The engineers in LMVD are challenged by a variety of environmental and geologic factors. Some of the major considerations are:

a. Many of the projects in the St. Louis and Memphis Districts are subject to moderately cold weather. The locks and dams on the Mississippi River in the St. Louis District must be able to pass ice floes from colder areas.

b. A portion of the Memphis District is located in a zone of high seismic risk (i.e. zone 3).

c. Several projects in the Vicksburg and New Orleans Districts are located in channels containing silty sands and fine sands. It has been difficult to control the severe scour problems in these areas.

d. The structures in the New Orleans District are located in a coastal environment and require special attention to control corrosion.

e. Our structures are founded on all types of materials. Pile foundations are common in the alluvial valley and along the coast. Most of the structures at the multipurpose reservoirs are founded on limestone, shale, or other impervious materials. The tendencies of shale strata to swell or slake were major factors which influenced our engineering decisions regarding location, arrangement, design, and construction of some projects. Extensive rock bolting programs have also been required to control stress relief during excavation.

Purpose and Scope

The following discussion is basically concerned with defining the role of the computer in structural engineering. This is not easy because many engineers disagree about the relative advantages and disadvantages of using the computer in a design office. Guidance from textbooks is limited to application of computers primarily for research rather than for producing design reports and contract documents.

This discussion will include:

a. Examples of how the computer has been used by designers in

LMVD (both successfully and unsuccessfully).

b. A brief examination of how our engineers are hampered by present policies and equipment.

c. Recent actions taken in LMVD to improve our process of developing computer programs.

d. LMVD's goals for computer-aided structural engineering.

Software

Sources of programs

There are six offices involved in the development of computer programs for structural engineers in LMVD (i.e. the four Districts, the Division Office, and the WES Computer Analysis Branch (CAB)).

The Division Office is limited to coordinating program development because of its small staff. Expert programming assistance is locally available to LMVD from the WES CAB. Special funds are provided in the LMVD budget for this assistance, which has included program development, maintenance, conversion, documentation, and training.

Many of the structural engineers in each District are computer oriented and they receive limited programming assistance from the Automatic Data Processing (ADP) Center.

A unique organization, The Systems and Programming Branch (S&PB), exists in the New Orleans District. All ADP activities for the Engineering Division, including technical programming, are performed in this branch. S&PB was established in 1969 because of a recommendation by the Engineer Inspector General in 1968. That recommendation prompted an engineering organizational study which revealed a strong interdependence between the programming and engineering efforts.

Such an organization can:

a. Improve coordination and eliminate duplication of ADP activities.

b. Improve procedures for standardizing and controlling program requirements.

c. Enable the District to develop systems of programs with broad applications.

d. Provide training and assistance to all engineers.

Major programs and systems have been developed by the systems and programming branch in the New Orleans District including:

a. Mass storage and retrieval systems, available to all users, for topographic, hydrographic, and hydrologic data.

b. Three soils engineering programs accepted for Corps-wide use.

c. Six structural design programs, currently being placed on the Corps system at WES.

Some District Offices in LMVD have been developing computer programs since about 1960. A list of the programs presently used by our Districts is inclosed. Most of our programs were written by engineers in the Structures Sections using funds and time scheduled for a specific project. Some of these programs were entirely developed by one District, others are modifications and/or expansions of the work from other offices, universities, or research centers.

Types of programs

Our structural engineers need three types of programs:

a. Structural analysis. Programs using matrix methods to analyze beams, frames, and pile foundations; finite element models, conventional stability analyses of walls and monoliths, conventional load computations for tainter gates, I-walls, etc.

b. Structural design codes. Programs containing the provisions of the AISC, ACI, EM 1110-1-2101, etc., for proportioning steel and concrete members.

c. Interactive design of hydraulic structures. These programs contain routines for performing the functions listed in categories a and b above, and permit the user to repeat these functions until a satisfactory structure is developed.

Most of our programs are for structural analysis or have limited capabilities for design and review (i.e. categories a and b above).

Our attempts to produce truly interactive programs for designing hydraulic structures (i.e. category c above) have been uneconomical and unproductive. Unsatisfactory results have been experienced by our Districts acting independently, and also in cooperative efforts by LMVD, the WES CAB, and the Districts.

Objectives of computer-
aided structural engineering

Computer programs have been effectively used by our structural designers to achieve five objectives:

a. To reduce design time and/or costs.

b. To reduce construction costs.

c. To respond rapidly during emergencies.

d. To perform detailed conventional analysis.

e. To perform sophisticated analyses which are impractical by manual computations.

Some examples of effective computer-aided structural engineering will be discussed.

Design time and/or cost reduction. Two examples are documented. The first example involved two programs used by the New Orleans District for the analysis of I-type floodwalls (Figure 2).

One of these programs determines the required penetration of a

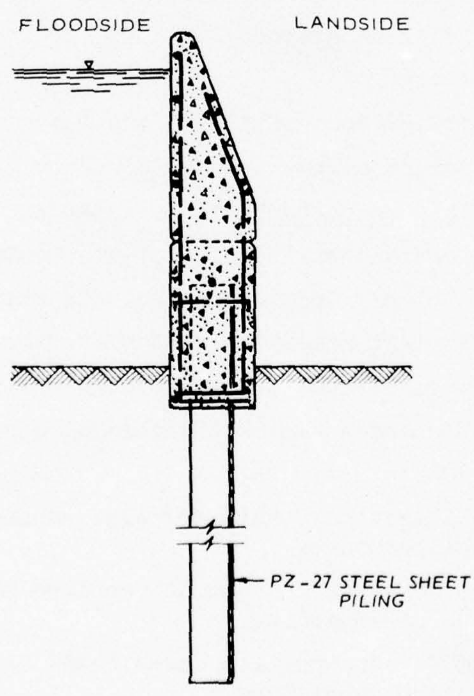


Figure 2. Typical I-wall section

cantilever I-wall and computes the net pressure diagram due to hydrostatic pressures, wave forces, and active and passive earth pressures. The second program computes the variation in shear and moment, and the deflection at the top of the wall.

These programs reduce the time required for design by 8 man-hours per case. The programs have been used to design approximately 15 miles of floodwall and will be used for an additional 7 miles.

The second example is a program named GFRAME which analyzes planar rigid frames using stiffness techniques. This program was written in the Memphis District and the WES CAB has added a computer graphic subroutine for plotting input data, shear and moment diagrams, and the deformed shape (Figures 3-6).

It would require about 3 to 5 man-days without a computer to analyze this complex frame, draw the shear and moment diagrams, and check the results. For production work involving large numbers of such frames, design aids could be developed to reduce this time to about 1 man-day. The same tasks can be completed in about 2 to 4 man-hours by using GFRAME without the graphic routines, or in 20 min if the graphic routines are used.

Many of our applications of GFRAME are for simpler frames, but the records at WES indicate that GFRAME is used 4 to 6 times per day.

<u>Construction cost reduction.</u> In 1957 the St. Louis District was designing flood protection for the city of St. Louis. Since 7 miles of this project were highly industrialized, the only feasible solution was floodwalls. The first reach included 8500 ft of floodwall which was completely designed without the aid of the computer. However, a program was written to check these conventional designs.

This program determined:

<u>a</u>. A floodwall section stable for sliding and overturning and the bearing pressure.

<u>b</u>. The values of shear and moment required to design the reinforced concrete members.

<u>c</u>. The estimated construction costs based on computed concrete and excavation quantities.

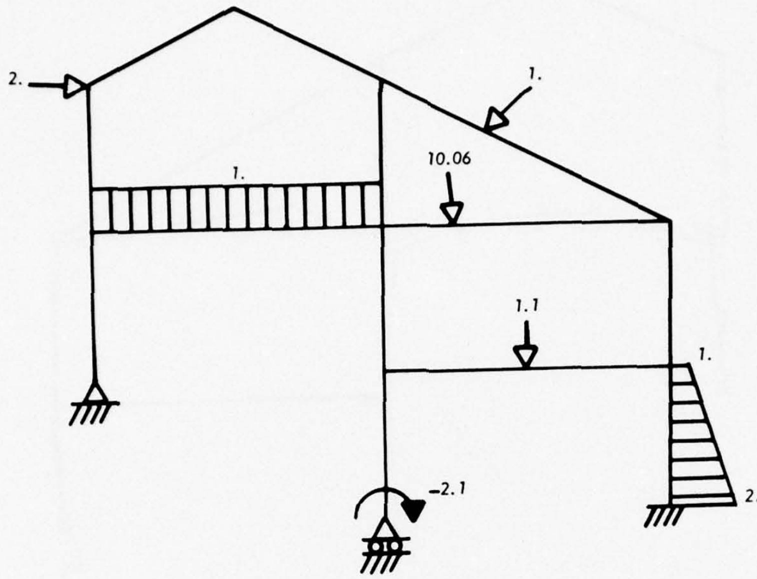


Figure 3. Computer graphic for loading case

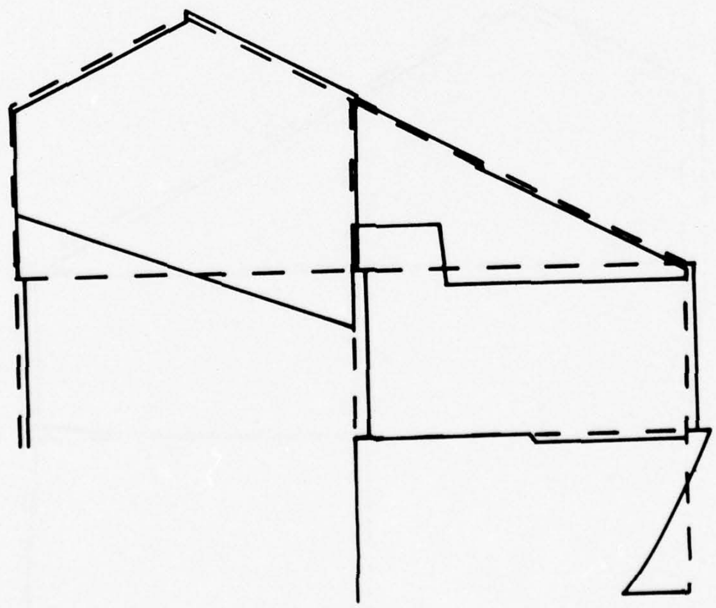


Figure 4. Computer graphic of shear diagram

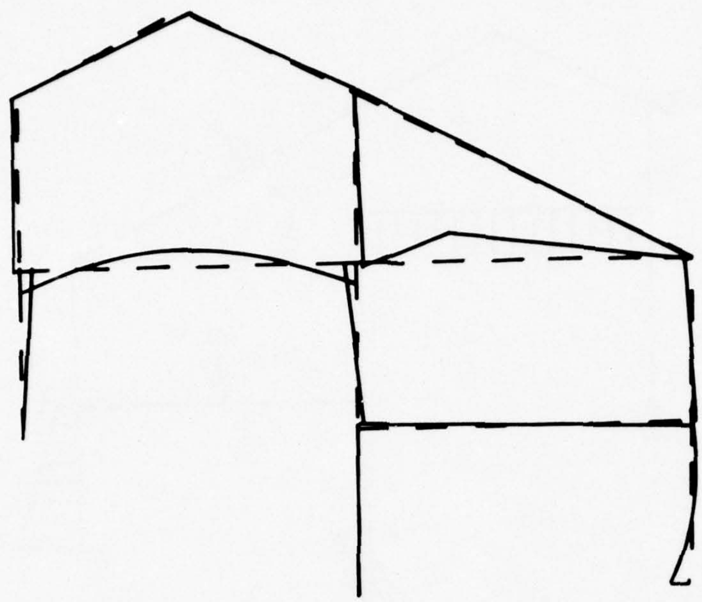


Figure 5. Computer graphic of moment diagram

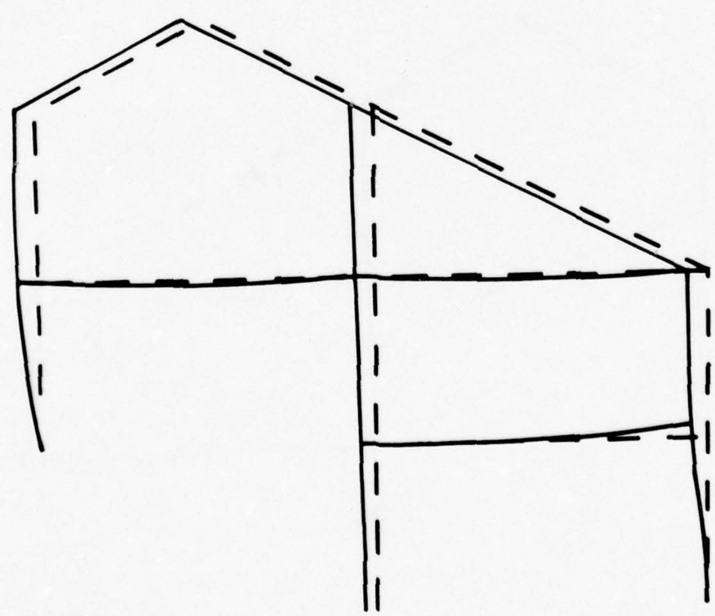


Figure 6. Computer graphic of deformed shape

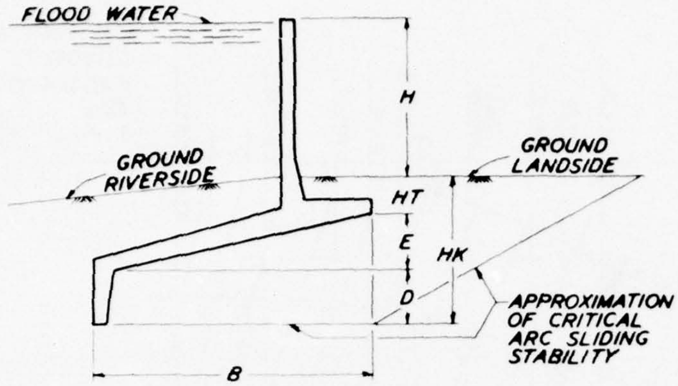


Figure 7. Typical "T"-type floodwall

A typical section designed by the computer is shown in Figure 7. The height of the wall is denoted as H . The designer can change the slope of the base, the position of the stem on the base, the depth of embedment of the toe HT , or the depth of the key HK .

Designers used the program to investigate a few alternative sections and discovered that a systematic search for an optimum section, based on cost, would result in substantial savings. A set of design curves, as shown in Figure 8, were generated by the computer. By using these curves the estimated cost of 1.6 miles of floodwall was reduced from $6,818,000 to $5,719,000 (or approximately $2,500,000, based on the value of a dollar in 1975).

A final comment will illustrate another important point. Ironically, this program is not included on LMVD's list of available computer programs. Due to retirements, reassignments, inadequate documentation, etc., the District's staff has lost confidence in this program.

This situation should not reflect unfavorably on the District. District personnel developed a good program using project funds; they used it effectively and have no immediate floodwall designs scheduled. Should they be criticized for not using funds from other projects to document and publish this information?

<u>Rapid response during emergencies.</u> There are two excellent

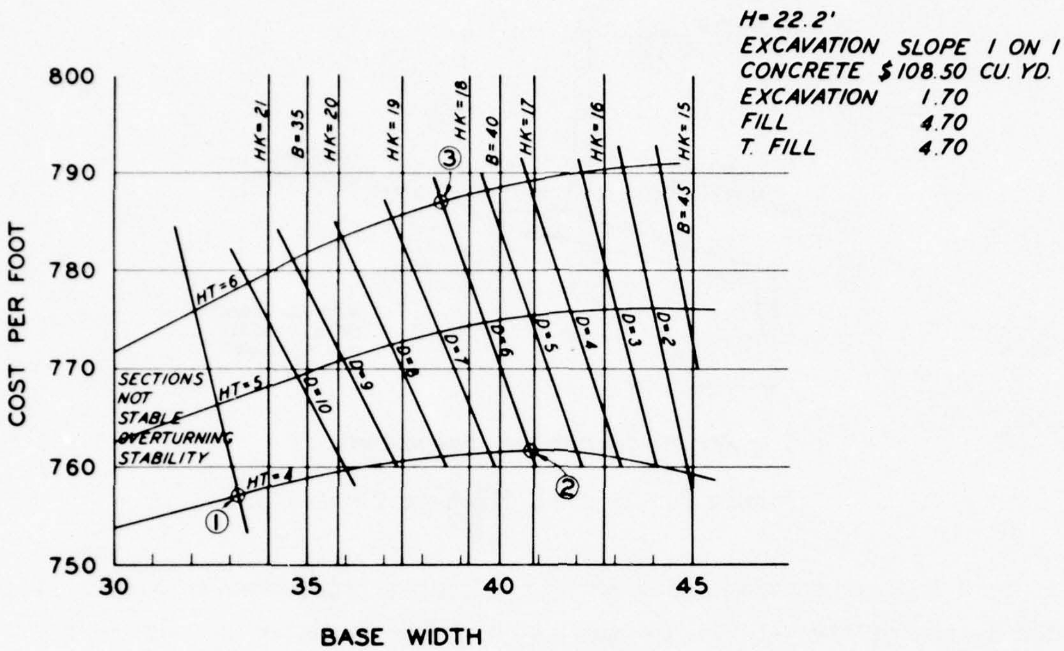


Figure 8. Computer generated design curves

examples of such crises in LMVD. The first example occurred in the St. Louis District in 1967 during construction of the main spillway for Lake Shelbyville (Figure 9).

A shear zone was discovered in a shale stratum which extended beneath the bases of the right nonoverflow section and four gravity overflow monoliths. Construction was halted for about 2 months while additional borings were obtained to map the shear zone.

Two computer programs were used to evaluate the stability of six alternative plans for modifying these monoliths. A total of 216 cases were investigated in about 10 days. These programs were later used for the main dam at the Clarence Cannon Reservoir.

Another example occurred in the New Orleans District during the 1973 flood. The Old River Low Sill Structure controls the flow from the Mississippi River into the Atchafalaya River and Basin. This structure is founded on steel H-piles which are about 85-90 ft long (Figure 10a).

Extremely high upstream velocities during the 1973 flood

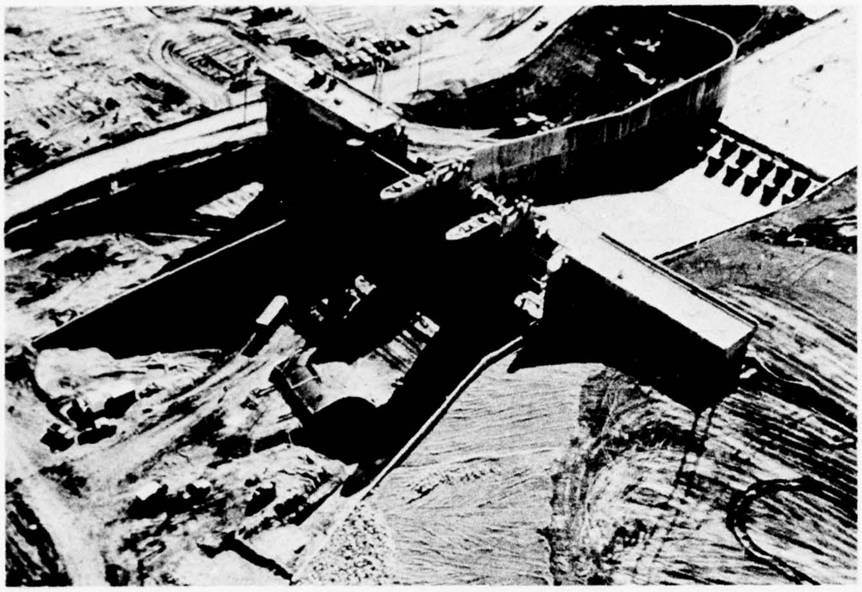
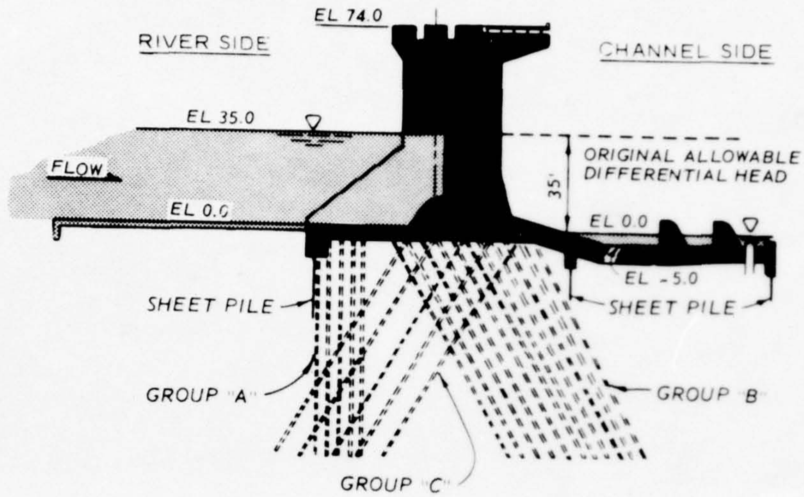


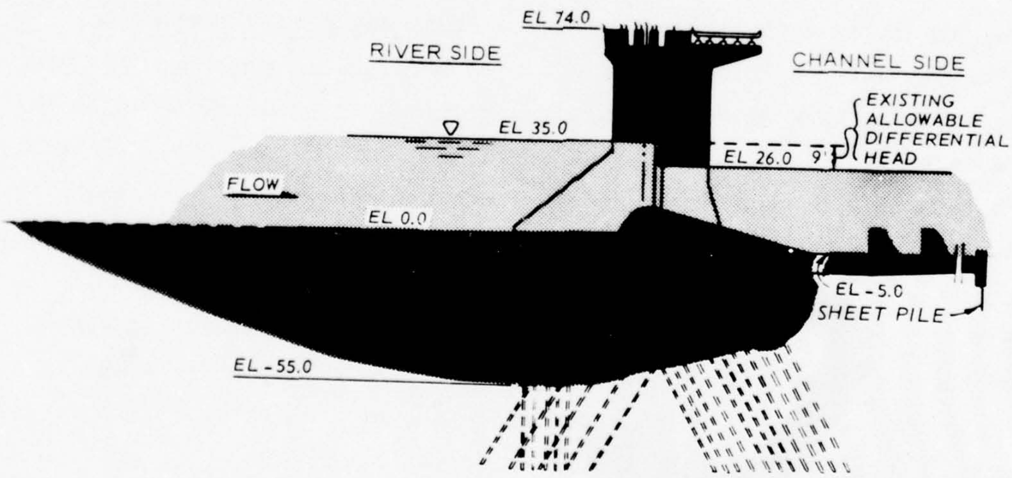
Figure 9. Construction at Lake Shelbyville, main spillway

undermined the approach apron and southeast upstream wingwall and scoured a hole approximately 55 ft deep below the structure. The upstream scour hole has been filled with riprap and the void beneath the structure was filled with 33,000 cu yd of grout (Figure 10b). Extensive analyses have been performed to evaluate the adequacy of the rehabilitated structure and to formulate a permanent solution. Originally this structure was designed to withstand a maximum differential head of 35 ft. The District has prepared a set of allowable operating curves for the full range of headwater stages (Figure 11). These curves indicate the safe differential head which the rehabilitated structure can resist without overloading the pile foundation.

The pile foundation for the rehabilitated structure was analyzed using the 3-D pile analysis program developed by the St. Louis District. Generating these allowable operating curves represents approximately 5100 man-hours of engineering effort and the anlysis of 2234 load cases using the 3-D pile program. This task would have been impossible (just 5 years ago) without the aid of a computer.



a. Before 1973 flood



b. With hole scoured during 1973 flood filled with grout

Figure 10. Old River Low Sill Structure

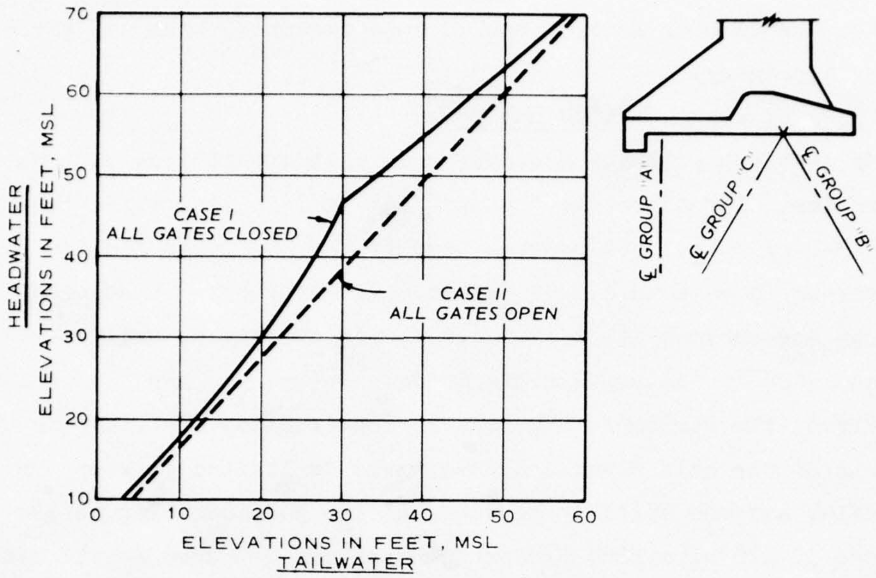


Figure 11. Allowable operating curves for Old River Structure

Performance of detailed conventional analyses

Almost all computer programs can be used in this capacity. A program used to evaluate the loads and reactions which act on tainter gates will be briefly discussed. This choice seems appropriate since few hydraulic structures are more complex and these gates are very common on Corps projects.

Several such programs are available from different offices. These programs are capable of accounting for:

a. The differences in geometric layout for flood control or navigation projects (i.e. hoist location, trunnion location, direction of hoist rotation, etc).

b. Variations in applied forces at all possible pool elevations and/or gate openings.

c. The effect of friction forces which act along the side seals and at the trunnion pin. The direction of the frictional forces is different if the gate is being raised or lowered.

Such a program has been used in the St. Louis District for three projects and it is available for the dams on the Red River Waterway in the New Orleans District. The information from this program is used

to design the tainter gate, trunnion yoke assembly, trunnion girder, and hoisting machinery.

Performance of sophisticated analyses

My last two examples are concerned with future applications of the computer. The adjective "future" may be deceiving since five years ago the 3-D pile analysis program used by the St. Louis and New Orleans Districts would have been included in this category. These examples represent the current limit of a designer's ability to analyze 3-D structures for static and dynamic loads.

First, the St. Louis District is constructing the Clarence Cannon Reservoir on the Salt River. A powerhouse is located between the left nonoverflow and the spillway sections of the main dam (Figure 12). There are 32-170 wire BBRV prestressed tendons embedded in the upstream face of the powerhouse. The manufacturer of the tendons has illustrated this design in recent issues of "Civil Engineering," but the real problem is not apparent from the cross section shown in Figure 13. A comparison of that cross section (typical of the adjacent nonoverflow monolith) with a cross section through the erection bay shows why post-tensioning is desirable to maintain compression along the upstream face and control cracking (Figure 14). The horizontal variation in cross section throughout the powerhouse is more evident in an isometric view (Figure 15). These irregularities make it impossible to formulate a realistic, 2-D analysis. A simplified analysis which only satisfied the applicable equilibrium conditions was used to design this prestressing system. These simplified analyses are convenient and necessary, but they are highly dependent on engineering judgment, must be conservative (and hence uneconomical) because of the many factors which cannot be evaluated and are very time consuming to design and review (6 man-weeks in LMVD alone).

A second example is connected with the W. G. Huxtable Pump Station. This station is being constructed by the Memphis District and has a capacity of 12,000 cfs (Figure 16). This project is located in zone 3 on the seismic risk map. A uniform, fine sand substratum was present beneath the structure. This material was replaced with soil cement to

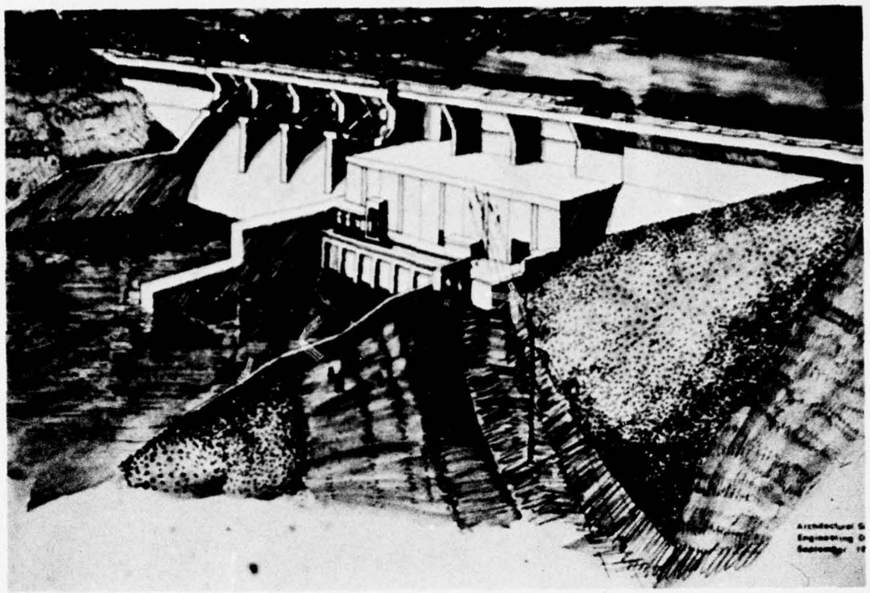


Figure 12. Main dam, Clarence Cannon Reservoir

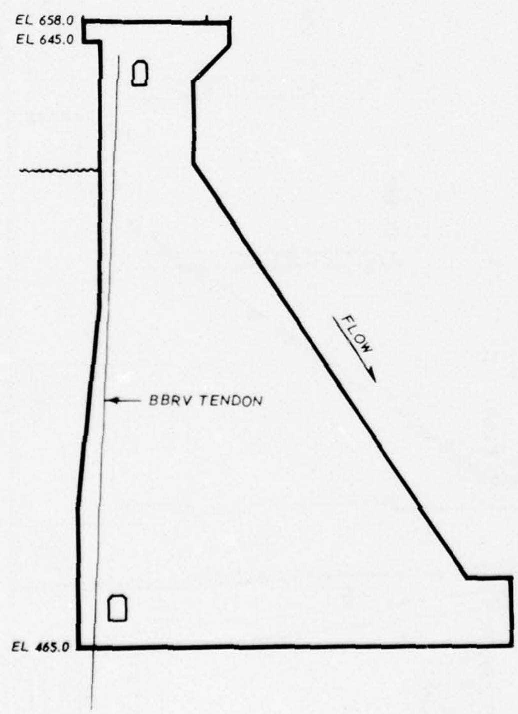


Figure 13. Cross section, powerhouse, Clarence Cannon Dam

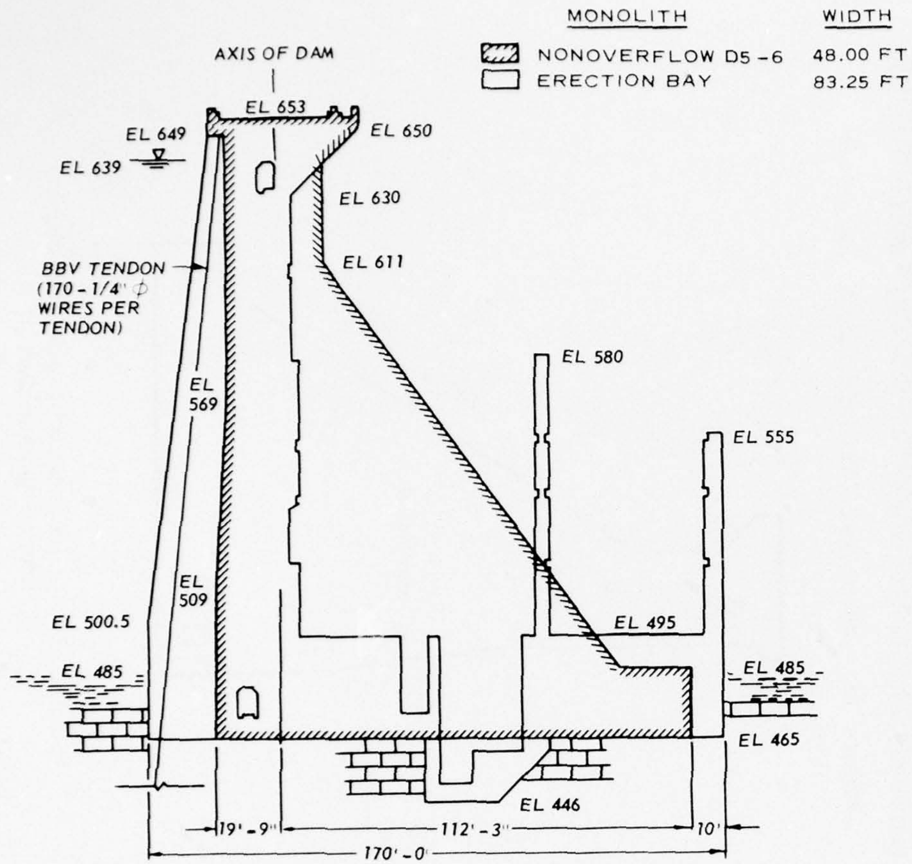


Figure 14. Comparison of centerline cross sections of erection bay and adjacent nonoverflow monolith

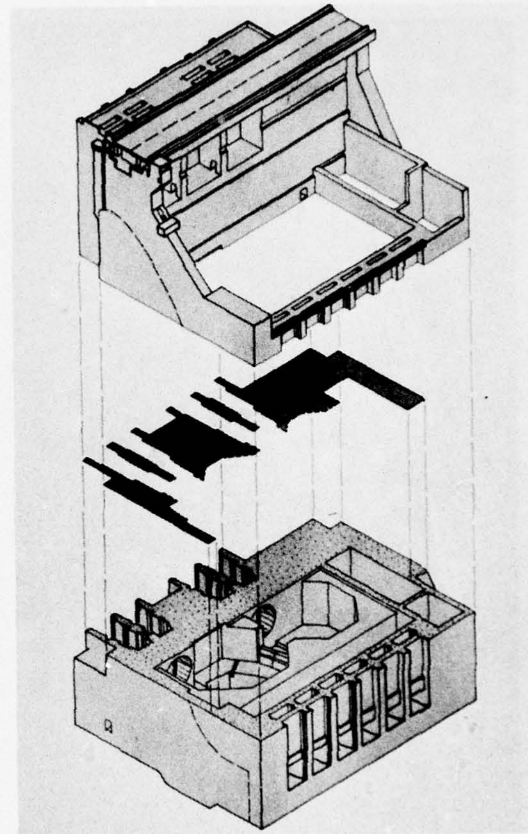


Figure 15. Powerhouse isometric section el 538.0

Figure 16. W. G. Huxtable Pump Station

be sure that liquefaction will not occur. The thicknesses varied from 7 to 23 ft.

The structural analysis for lateral seismic loads was based on *equivalent static forces* due to a horizontal ground acceleration of 0.1 g. Such techniques are crude, but practical and adequate for most structures and areas in LMVD. However, more reliable and refined techniques should be available to designers for critical facilities such as the Huxtable Pump Station. Response spectrum and time history modal analysis methods are available but require large capacity computers and special training for the users.

These examples show that the highly publicized and criticized finite element method is the only tool available to solve a special class of problems which occur in the Corps Civil Works Program. Reasonable efforts should be continued to develop this technique for use in a design office since it is necessary to solve problems in the real world, not just academic exercises. In particular, our efforts should be directed at obtaining software (preprocessors and postprocessors) which

simplify and expedite the preparation of input data and interpretation of output.

These examples have illustrated the value of the computer to our structural engineers.

Difficulties associated with
<u>computer-aided structural engineering</u>

The disadvantages of using the computer will now be discussed. There are five general types of problems associated with computer usage:

<u>a</u>. Control and supervision of computer usage.

<u>b</u>. Factors affecting program development.

<u>c</u>. Documentation.

<u>d</u>. Dissemination of information.

<u>e</u>. Training.

<u>Control and supervision of computer usages.</u> A vocal minority of engineers seem convinced that the computer "uses" engineers unproductively and that the computer is really unnecessary for sound structural engineering. This type of problem is mentioned in Jim Wooten's article, "Wooten's Third Law and Steel Column Design," in Vol 11, No. 2, of <u>Modern Steel Construction.</u>

"Wooten's Third Law states, "The acquisition of uncommon knowledge inhibits the application of common sense." Perhaps the best illustration of the Third Law is the computer, a machine which can absorb millions of bits of the most sophisticated uncommon knowledge and still remain abysmally stupid. The computer's rapid solution of stupendous slope deflection equations and massive stiffness matrices renders obsolete the necessity of rationalizing and simplifying problems--or even of understanding them. No one need feel guilty for using simple solutions when the computer can make them extremely complicated. Anyone can plug a false assumption into an incorrect formula and, in a flash, arrive at a ridiculous answer, inaccurate to ten decimal places."

Such statements are misleading. The examples which were presented show that the computer is a practical tool for structural engineers. Like all other phases of design, computer usage must be well conceived

and well supervised in order to be effective.

Wooten's Third Law also applies to the other problems associated with computer usage; however, the key word in Wooten's Law is "inhibit." Common sense will eventually prevail and will yield solutions which use the computer effectively.

Factors affecting program development. Developing computer programs in a design office is a confusing, frustrating, and inefficient venture which involves complex technology and significant expenditures of time and money. These difficulties will be discussed in detail.

The present situation is certainly frustrating, but understandably so. We are the first generation of structural engineers to use the computer and there is very little guidance available on how to use it effectively. Many of our programs were developed by young, inexperienced engineers using a trial and error process. The involvement of senior engineers has been minimal since they were more productive using conventional techniques and were equally inexperienced with the computer.

There are additional factors which add to the confusion surrounding program development. The computer industry is very dynamic. When moment distribution and slope deflection were published decades ago, these methods of structural analysis were essentially complete, but the ASCE transactions were filled with articles on these topics for 25 years. In 15 years the state of computer technology has dramatically changed. Present computers are larger and faster, time-sharing terminals are readily available, and the future use of CRT terminals will have a tremendous impact. These enhancements in computer technology have made the computational capabilities of the average designer almost unlimited. Hence, computer programs must not only be updated, but more complex programs must be written to fully use the capabilities of current hardware.

Most of our programs were developed in District Offices using time and funds scheduled for a specific project. Our successes and failures using this "bootleg" approach have distorted everyone's perspective of what is required to develop and use the computer efficiently for

structural design. Our failures have justifiably created resistance to computer usage among some supervisors and managers. Our successes have demonstrated the potential advantages of computer-aided design, but we must remember that these successes were created by dedicated engineers whose persistent efforts show <u>what</u> can be accomplished. We should not continue to misinterpret their success as <u>how</u> computer programs should be developed.

The decentralized structure of the Corps offices has many advantages, but it is a definite disadvantage in the field of program development. The advantages of a large centralized engineering office include:

<u>a</u>. Information can be easily disseminated about available computer programs.

<u>b</u>. Simple procedures and policies are adequate for standardizing and controlling the development of computer programs.

<u>c</u>. A permanent staff of engineers can be assigned to develop computer-aided design techniques. It is difficult for any single office in the Corps to have even a small staff (i.e. one or two engineers) of specialists engaged in developing computer-aided design techniques because this manpower represents a significant percentage (perhaps 5 to 20 percent) of the total capability in that office. This is considered to be the major disadvantage of our decentralized structure. This conference is an excellent opportunity to unify the design elements of the Corps and gain some of the advantages of a large centralized engineering office.

<u>d</u>. Implementation of computer-aided design techniques requires a staff of specialists in the Engineering Division because our ADP Centers do not provide personnel to do engineering programming. The ADP Centers in District Offices are staffed to provide programming capability for the least sophisticated users (i.e. those who have no computer training). Since engineers receive ADP training as part of their college education, the ADP Center provides guidance and debugging as needed, and writes engineering programs <u>as available time permits.</u> This policy is based on the premise that personnel who will use a program are better equipped to write the program because they have full knowledge of the subject. If this policy is to be effectively implemented, the Engineering Division, and structural engineers in particular, must have a staff available, <u>as necessary,</u> to insure that programs will be developed without jeopardizing our project schedules.

There is only one feasible solution to <u>improving our efficiency.</u> Proper

coordination, at all levels within the Corps, will produce reasonable, economical results. The following actions were taken in LMVD to more fully use our resources in the District, Division, and WES CAB Offices for computer-aided design.

In 1972 the LMVD Computer Coordinating Committee was established in the Division Office. The Assistant Chief, Engineering Division, serves as the chairman and each branch in the engineering division has one representative. The activities of the committee include:

a. Promoting ADP efforts by the Districts in engineering design and analysis, and development of standard programs for this purpose.

b. Developing the engineering phase of the annual LMVD budget for programming assistance performed by WES, and reviewing progress at appropriate intervals throughout the year.

c. Appointing an LMVD/MRC project engineer for each project being conducted under item b above.

d. Maintaining liaison with our technical counterparts in OCE engaged in similar ADP activities.

In 1974 the LMVD Computer-Aided Structural Design (CASD) Committee was established. This group is a direct link between structural engineers in the Districts and Division Offices and the CAB. Each office has two representatives. This committee meets quarterly to select problems of mutual interest, review progress, and coordinate design criteria. The computer programs are written by the WES CAB. The WES CAB has recruited a computer-oriented, experienced structural engineer who acts as the project engineer for the CASD activities. The level of funding for this activity is sufficient to cover the project engineer's annual salary plus overhead. The initial efforts of this committee have been directed at writing interactive design programs for hydraulic structures.

The activities of the LMVD CASD Committee allow our Districts to develop complex programs which are beyond the resources (i.e. available time and manpower, not ability) of any single District, and to continue their individual efforts without any additional constraints.

This approach to computer-aided structural design is only one year old and cannot be fully evaluated. The plans and goals of this committee will be discussed later.

Documentation. In general, there are two major problems:

a. Programs available from other sources are usually inadequately documented.

b. Proper documentation is an expensive feature of program development, both initially and as a program is updated, modified, and expanded.

Users have no confidence in programs which are not adequately documented. Until the Corps establishes sufficient staff and funds for documenting programs, the procurement and use of existing programs must continue informally. This conference was an excellent opportunity to establish personal contacts which are reliable sources of useful programs.

Dissemination of information. There are two major problems:

a. Many useful programs are available but are unknown to potential users.

b. Many offices develop similar programs simultaneously or duplicate an existing program.

The establishment of the Engineering Computer Programs Library by OCE (ER 1110-1-11, dated 25 Aug 75) is a major step in solving these problems.

Another effective method of disseminating information to structural engineers is to reference useful computer programs for hydraulic structures in the applicable Engineer Manuals. Our structural engineers usually refer to the EM's for design guidance and it seems logical to include guidance on available computer-aided design techniques within this established behavioral pattern.

The programs referenced in the EM's should:

a. Have a well documented user's manual.

b. Be available to all Corps Offices via at least one time-sharing system.

c. Be reasonably representative of the current practices employed by the Corps designers.

d. Have funds allocated for maintenance.

e. Have a designated agency (i.e. person, Corps Office, etc.) responsible for training, maintenance, etc.

Training. Our present situation regarding computer usage is so

disorganized that our major resource is the quality of our engineers. Hence, proper training to improve and maintain a high level of expertise is essential.

Training can consist of college courses, on-the-job training, and seminars. The best way to develop understanding, expertise, and confidence in modeling structures using the computer is actual practice in preparing input data, and interpreting the output. Some engineers can do this in their assigned work, others have work assignments for which the computer cannot be used. Thus, time should be scheduled for engineers to gain experience using the computer.

It is the policy of LMVD to have the WES CAB conduct a workshop for each completed program. These workshops include:

a. Lectures describing the theory, assumptions, references, and limitations which are the basis of the program.

b. Each participant prepares input data and interprets the output for assigned problems.

c. An opportunity for participants to work examples of their choice using the subject computer program.

In summary, there are excellent examples in LMVD of how computer programs are used effectively by structural engineers. We must recognize that these programs were developed by a generation of pioneers in computer usage. Many of the present difficulties can be controlled or eliminated by improved coordination at all levels within the Corps. Permanent solutions to other problems require additional staff and funds.

Hardware

The types of hardware available in LMVD and the problems associated with their use will be briefly discussed.

Each District has direct access to a G-225 computer and remote access to ADP Centers at WES, MCAUTO Corporation, or on the INFONET system in California.

Districts

The local hardware consists mainly of communication devices

(time-sharing teletypes, COPE 1200 Terminals) that can access remote computers. The G-225 computer serves mainly as a card reader and printer to run batch programs on the G-635 at WES. A number of CRT terminals will be available soon in each District.

WES

In 1973 WES transferred its engineering users from its G-437 computer to a newly acquired G-635 system to accommodate the COEMIS users. The G-635 computer has powerful computational capabilities; however, these capabilities were scaled for the work load as it existed several years ago, not for the present and future work loads. Also, the G-635 has been on the market for 10 years and it does not possess the capabilities and reliability of current systems. Specific deficiencies include limited main memory, disc storage, and magnetic tape capacity. These deficiencies and the increased remote batch, local batch, and time-sharing work loads make the time-sharing response time and the time required to process batch jobs unacceptably slow.

WES has recently been authorized to upgrade the G-635 to increase disc, main memory, magnetic tape, and communications capabilities. These upgrades were operational in January 1976. The upgraded system has about twice the throughput capabilities of the G-635. This will provide a period of relief to users before the system again approaches saturation.

Since WES has been the main source of production computer service to our Districts, the WES personnel frequently bear the brunt of criticism for inadequacies in the current computer hardware and for the apparent lack of reliable and responsive services and support. This is not an accurate reflection of the efforts by the many competent professionals at WES who have excellent ideas and plans. Instead it is an indication of the limited capability of the equipment they have been allowed to procure, and the inadequate size of staff available to service the large group of users dependent upon WES for services.

MCAUTO CORPORATION

Since our offices have only had access to MCAUTO for 6 months, a full evaluation is not possible. Our present opinion is that MCAUTO has excellent equipment and services which satisfy our immediate and

future requirements. Other computer services such as Boeing, CSC, etc., may be able to offer similar facilities to LMVD and other Corps Offices in an effective manner.

LMVD Plans and Goals

The plan of action for computer-aided structural engineering in LMVD includes:

General

The present equipment, services, and support available from WES should be supplemented by those of a highly qualified commercial source. The contract negotiated with the MCAUTO Corporation is considered to be a satisfactory solution and should be continued.

Equipment

More high speed teletypes and CRT terminals are needed to minimize the interaction time between engineers and the computer. A ratio of 15 users per console is desirable.

Software

The three types of programs used by our engineers are in different stages of development and each type requires special attention. Our major effort will be concentrated on two items:

Training for engineers in STRUDL. This training will have immediate and long range benefits. Our engineers can use STRUDL's analysis and design capabilities for current projects. By using STRUDL our engineers will learn its limitations for designing hydraulic structures (i.e. it does not design plates or analyze pile foundations, etc.). New programs can then be developed to provide the additional features required for hydraulic structures.

The WES CAB and MCAUTO Corporation have already conducted a two-day training course on STRUDL and FASTDRAW in each District. With this background, our engineers have used STRUDL and FASTDRAW to check the design of a tainter gate. STRUDL was used to analyze the gate and check the three horizontal girders and all strut arm members according to the AISC Code. This solution cost $95 and indicated a possible time

saving, compared with conventional methods, of about 70 percent. STRUDL is also useful for design (i.e., member selection); however these capabilities are more complex to use efficiently and have not been as fully developed.

Dr. Leroy Emkin of Georgia Institute of Technology is currently preparing a technical guide on how to efficiently use STRUDL and FASTDRAW for designing tainter gates. This guidance will be available in January 1976.

Interactive design programs for hydraulic structures. These complex programs must be developed by the Corps because no other source shares our interest in hydraulic structures. Such programs are more complex than any existing structural engineering program which was developed in LMVD. Because of this complexity, a cooperative effort among several offices is essential.

The LMVD CASD Committee is developing an interactive design program for tainter gates. This program was operational in January 1976 and was used immediately by the New Orleans District for Lock and Dam No. 1 of the Red River Waterways Project.

Since interactive design programs are so complex, and therefore expensive, there must be sound justification for their development. As these interactive design programs become available, the following benefits and courses of action are feasible:

a. Significant reductions in design time.

b. Improved coordination of A/E contracts.

c. Standardization of structures.

d. Development and refinement of design techniques to reduce construction costs.

The details of each item will be discussed.

Significant reductions in design time. Our limited experience with STRUDL and computer graphics shows that design time can be significantly reduced with interactive programs. Computer graphic programs can be developed which display drawings of reinforcement, concrete dimensions, etc. These drawings will be comparable in quality to an engineer's design sketch. Hence, these programs will allow the existing

staff to handle a larger volume of the design work load without A/E services.

Since 1970 our annual E&D budget has increased from approximately 12.4 to 42.4 million dollars. In FY 75 approximately 25 percent of our design work was done by using A/E services. Experience indicates that excessive use of A/E services to achieve our immediate goals will degrade the expertise of the District design staffs. This potential problem has been recognized in LMVD and the computer is considered to be an important means of augmenting our current capability.

Improved coordination of A/E contracts. Many basic decisions regarding the type of structure, substructure, etc., can be resolved expeditiously since the data for comparing alternatives can be rapidly generated by the computer.

Standardization of structures. A standard set of contract drawings can be developed for many hydraulic structures including tainter gates and miter gates. These standards would be similar to those used by the Bureau of Public Roads for highway bridges. The interactive design program being developed by the LMVD CASD Committee can be used for this purpose. When these standards are available, our engineers will have additional time to devote to structures which cannot be standardized.

Develop and refine design techniques to reduce construction costs. It is impractical to expect either computer programs or new design expertise to develop spontaneously. A coordinated effort is required to adapt the results of modern engineering research to a convenient format for designing hydraulic structures. A portion of the time saved by using interactive design programs can be allocated for this purpose. Two possible areas to explore are:

a. Using segmental, prestressed concrete units for hydraulic structures.

b. Adapting ultimate strength analysis and design techniques to hydraulic structures.

Summary and Recommendations

Based on our experiences the LMVD recommends that appropriate action be taken to resolve the following difficulties:

Hardware

There is one major problem with the Corps' equipment which is common to all users including structural engineers. Existing policies and regulations regarding acquisition of computer equipment require 2 to 3 years minimum for the procurement process, and result in obtaining equipment which is approaching obsolescence.

The solution to this problem is considered to lie beyond the field of computer-aided structural engineering. This situation is not expected to improve until higher echelons of authority revise formal regulations regarding computer procurement, and adopt more flexible and realistic policies concerning the scope and importance of computer usage by engineers in the Corps. Continuation of the present policies not only handicaps our R&D organizations, but also severely restricts the ability of our District Offices to produce economical, competitive designs for authorized projects. Effective, progressive computer use is essential to lowering construction and design costs, maintaining and minimizing schedules, and effectively using A/E services for structural design.

The potential for cost reduction, as discussed above, should be especially appealing since the Corps must compete with other Federal Agencies for its share of tax dollars. The intensity of this competition is exemplified in the 10 Jul 75 issue of the ENR. That issue contained an article concerning the USBR's reduction in force from 10,300 to 8,300 since 1970, and their efforts to develop new fields of expertise although constrained by a budget geared to completing authorized projects. Until this problem is resolved, it will be necessary for our offices to supplement the services available from WES with those of MCAUTO Corporation, or an equal commercial vendor.

Documentation and dissemination of information

This conference and the presence of the Engineering Computer

Programs Library (ECPL) at WES are two important steps in disseminating information. Also, our EM's should be updated to include guidance on current computer-aided design techniques for hydraulic structures. This office recommends that additional action be taken to insure that the programs available in the ECPL and future EM's are well documented. Some mechanism should be established within the Corps to fund a full-time staff for this purpose.

Software

Advancements in computer technology have made the computational capabilities of the average designer almost unlimited. However, future programs must be more complex to fully use the capabilities of current hardware. Hence, program development will function at a new level. Our District Offices will continue to be our primary source of programs, but our coordination effort, at all levels of the Corps, must be improved to achieve economical, effective results. Hence, the following recommendations are offered for consideration by each office.

We consider the concept of the LMVD CASD Committee to be applicable to most Corps Offices. Consideration should be given to combining several offices, with similar interests, into regional CASD groups and coordinating the overall effort in OCE.

Most of our programs were developed in District Offices using time and funds scheduled for a specific project. This "bootleg" approach has distorted our perspective of what is required to develop and use the computer effectively. New methods of monitoring progress, recognizing problems, and accounting for actual costs should be established in each District without stifling the designer's initiative to seek more realistic and economical solutions.

Each project engineer should be responsible for evaluating the use of computer-aided design techniques for his current and future work load. This evaluation should be reviewed and approved by his supervisor and the Chief, Structures Section. The evaluation should include:

a. Possible uses of the computer.

b. Are such programs available? Source? Does the Project Engineer have confidence in the available programs?

c. Who would develop new programs (i.e. structural engineers, CASD Committee, etc.)?

d. Which programs are desirable? Necessary?

e. When must these programs be available to insure that project schedules are not jeopardized?

f. Can these programs be used in the immediate future for similar projects?

g. Can temporary employees (co-op, summer students, local graduate students, etc.), be used for documentation?

h. If programs are to be developed, a progress chart should be prepared which identifies the major divisions of work, the time scheduled for each task, etc. This chart will be an aid for planning and reporting progress.

i. The progress charts for all programming attempts should be filed for future reference.

j. Which application has the best chance for success?

To fully implement a plan for computer-aided design it will be necessary to have a staff of specialists in the Engineering Division. These specialists are necessary because ADP Centers do not provide personnel to do engineering programming.

There are relative advantages to having this staff of specialists assigned to a central branch in the Engineering Division (i.e. similar to the Systems and Programming Branch in the New Orleans District), or assigned to each element. This is a matter of individual preference to a large degree. The key factor which our offices must recognize is that computer-aided design requires full-time support which is not available in our ADP Centers.

Districts with a large staff of structural engineers should consider designating three members of the Section as specialists in computer-aided design techniques. This unit would be responsible for providing expert advice to design engineers on computer-aided structural engineering, developing special purpose computer programs, and training other engineers and technicians.

This unit should consist of a:

a. Senior structural engineer. A permanent assignment with

responsibility for coordinating all computer-aided structural design tasks. This person must provide expertise and leadership in the techniques of computer-aided structural engineering.

b. Structural engineer. Numerous engineers could be rotated into this position to gain experience and confidence in the use of computer.

c. Engineering technician. This person would be familiar with and perform data preparation, computer systems operation, and FORTRAN coding. Numerous technicians could also be rotated into this position.

d. Temporary employees. This staff could be supplemented by temporary employees.

It should be emphasized that this unit of specialists would not only provide a source of expertise and leadership, but an orderly, effective means of providing on-the-job training. As previously stated, the present state of computer-aided design in the Corps is chaotic, and our chief resource is the quality of our personnel. Proper training is therefore essential to maintain and improve our current level of expertise.

Appendix A: Abstracts of Lower Mississippi Valley Division Structural Engineering Computer Programs

Memphis District

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.
Multiple Load Case Planar Rigid Frame Analysis (GFRAME)			713-G9-A1-040
PREPARING AGENCY			
Memphis District			
AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STATUS OF PROGRAM: STAGE
Robert E. Brittain	April 1970	Init	Op

A. PURPOSE OF PROGRAM

The program determines the joint displacements and rotations, member end moments, shears and axial loads, and structural reactions for planar rigid structures.

B. PROGRAM SPECIFICATIONS

The program is written in conversational FORTRAN.

C. METHODS

The program utilizes the stiffness matrix method for solution of joint displacements and rotations. The Cholesky decomposition method is used for solution of the resulting simultaneous equations using only the lower half-band of the coefficient matrix which is stored in a linear array. Structural reactions are determined by summation of forces and moments at the supports.

D. EQUIPMENT DETAILS

The program is written for the GE-430 time-sharing system which includes a Datanet 30, disc units, tape handlers, high speed printer, card reader and punch. User input and output to the system is by means of Teletypewriter Model 33.

E. INPUT-OUTPUT

Input consists of coordinates and fixity of each joint, geometry of each member, and loading on each member and joint for each loading condition.

Output consists of an input data check, error messages, joint displacements, member end moments, shears, and axial loads, and reactions.

F. ADDITIONAL REMARKS

External disc storage is used for input data file.
Object size is 12575 words.
The program is one of three programs developed for structural analysis. The other two are Planar Orthogonal Frame Analysis (713-G9-A1-1030) and Planar Pinned Truss Analysis (713-G9-A1-050).

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.
PCA-BM			None
PREPARING AGENCY			
Memphis District			
AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STAGE
Sefton Lucas			

A. PURPOSE OF PROGRAM

Post-processor for GFRAME.

B. PROGRAM SPECIFICATIONS

FORTRAN

C. METHODS

Computes moment at incremental points along a beam and calculates reinforcing requirements for axial load plus bending. Checks shear at the face of support and computes resisting moment of the section for bending.

D. EQUIPMENT DETAILS

Honeywell G-635 TSS.

E. INPUT-OUTPUT

Program is written for use on G-635 TSS, accessed via teletype terminal.

F. ADDITIONAL REMARKS

Not documented.

New Orleans District

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.
Forces on Inverted T-Wall			713-F5-A2-110
PREPARING AGENCY			
New Orleans District			
AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STAGE
C. W. Ruckstuhl, Jr.	Operational Oct 1971	MOD 6	Jan 69

A. PURPOSE OF PROGRAM

Compute summation of forces and moments on inverted concrete T-wall for each of a given number of load conditions. Also computes magnitude, location and direction of the resultant for each load condition. Wall stem may be sloped on protected side, but top and bottom of base must be horizontal. Sheet pile cut-off is assumed to be 100% impervious and 100% pervious, resulting in two load conditions for each set of different water elevations input.

B. PROGRAM SPECIFICATIONS

Program is written in ASA FORTRAN IV, binary file contains 8346 characters and creates 1 binary file that is stored on disc and used as part of the input for program 713-F5-A2-150. Also, the input data can be stored on a disc with file name D29002 or typed in as response to questions initiated by the program. The binary output file is named by the user and saved for use as binary input data with program 713-F5-A2-150 (K29004).

C. METHODS

Program is accessed on WES time-sharing system, User No. N609, binary program file no. K29002 (source program file no. K29001). A typical section is divided into components; the weight of each component (VOL x UNIT WT) is computed and added to sum of vertical forces. Horizontal forces are computed for each component using pressure coefficients and added to sum of horizontal forces. Each force is multiplied by the distance from the centroid of the force to the origin and added to sum of moments.

D. EQUIPMENT DETAILS

Program is written for use on GE-430 computer w/disc drives and time-sharing system, accessed via teletype ASR 33 terminal.

E. INPUT-OUTPUT

Input data consists of wall dimensions and elevations, elevations and unit weight of backfill, water elevations on each side of wall for each load case and and program control variables. Input data can be stored on disc under file D29002 prior to running program or typed in as response to questions initiated by the program. Output consists of summation of moments, vertical forces, horizontal forces and magnitude, location and direction of the resultant for each load condition. ~~The output can be printed~~

F. ADDITIONAL REMARKS

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM Computation of Applied Forces and Moments on an Inverted, Variable Depth T-Wall	**PROGRAM NO** 713-F3-A2-160
PREPARING AGENCY New Orleans District	

AUTHOR(S)	**DATE PROGRAM COMPLETED**	**STATUS OF PROGRAM** PHASE	STAGE
Leroy Brown	July 1974	Origin	Aug 73

A. PURPOSE OF PROGRAM

The purpose of the program is to compute the total applied forces and moments on an inverted T-wall that varies linearly in depth.

B. PROGRAM SPECIFICATIONS

This program is written in FORTRAN IV for the Honeywell 600 Computer.

C. METHODS

The T-wall is divided into segments; forces and moments are computed for each segment and accumulated algebraically to obtain the total forces and moments for the desired case(s).

D. EQUIPMENT DETAILS

Program uses Honeywell 600 Time-sharing System and model 33 teletypewriter.

E. INPUT-OUTPUT

Input is read from a data file; pertinent input data includes wall dimensions, unit weights, water elevations, ground profiles, uniform and concentrated loads and desired cases. Output consists of a detailed printout of forces and moments for each segment and a summary for each case; detailed printout can be omitted at user's option.

F. ADDITIONAL REMARKS

Engr ID Number = K29057
Data File = D29057

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.
Check for Columns under Biaxial Bending			713-F3-A2-130
PREPARING AGENCY New Orleans District			
AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STATUS OF PROGRAM: STAGE
D. J. Elguezabal, Jr.	Oper Nov 1971	ORIGIN	Oct 71

A. PURPOSE OF PROGRAM

Check reinforcing on columns under biaxial bending.

B. PROGRAM SPECIFICATIONS

Program is written in ASA FORTRAN. All input is by keyboard typing as the computer asks in conversational mode. Maximum of 20 reinforcing bars per column face. Reinforcing steel has to be symmetrical about axis.

C. METHODS

Method used is that used in the "Reinforced Concrete Design Handbook - Working Stress Method" ACI, 1965, p 66-74, 240-251.

D. EQUIPMENT DETAILS

This program is written for use on a GE-435 computer with time-sharing via teletype model 33 ASR terminal. Program length is 7125 characters and leaves 8727 words of unused memory.

E. INPUT-OUTPUT

Input consists of width and depth of column, rebar covers f_y, f_s, f'_c, n, number of bars and cross-sectional area of each, axial load and moments about the X and Y axis. Output is a list of coefficients and check on percentage of steel.

F. ADDITIONAL REMARKS

N/A

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM	PROGRAM NO.
HRENNIKOFF PILE ANALYSIS WITH SUMMATION OF RESULTS	713-F3-A2-150

PREPARING AGENCY

NOD, Corps of Engineers, P. O. Box 60267, New Orleans, Louisiana 70160

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STATUS OF PROGRAM: STAGE
R. Villarubia, G.M. Finley, C.W. Ruckstuhl, Jr., and D.J. Elguezabal	NOV 74	MOD 9	1968

A. PURPOSE OF PROGRAM

Compute actual axial and transverse loads, and allowable transverse loads, on each pile row for each set of applied forces and moments on a given pile arrangement of a battered pile foundation by the Hrennikoff Method.

B. PROGRAM SPECIFICATIONS

Program is written in FORTRAN with free-field input format, is segmented into two levels of overlays and requires 16K words (36-bit) of memory on the WES G-635 system under the FORTRAN time-sharing sub-system.

C. METHODS The method used for computation of actual pile loads is explained in "Analysis of Pile Foundations with Batter Piles", by A. Hrennikoff, ASCE Transactions, Vol 115, 1950, pp 351-382. The basis for the computation of the allowable transverse loads is the theory that the sum of the ratios of actual axial stress to allowable axial stress and maximum actual flexural stress to allowable flexural stress must not exceed unity. For hinged end piles, the coefficient for maximum moment is assumed to be 0,50 which is slightly greater than the coefficient indicated in "Generalized Solutions for Laterally Loaded Piles," by H. Matlock and L. C. Reese, ASCE Journal of Soil Mechanics, Vol 86, No. SM5, Proc. Paper 2626, Oct 1960, pp 63-91. Program has also been modified to accept values for a stratified soil. The program has not yet been expanded to compute allowable transverse loads for piles that are considered to have their heads fixed in the pile cap.

D. EQUIPMENT DETAILS

Program is written for use on a G-635 computer with GCOS operating system and FORTRAN time-sharing sub-system. Two disc files may be used for input and three scratch disc files are used. Program is accessed on the WES time-sharing system via remote terminal.

E. INPUT-OUTPUT Input consists of control variables, soil and pile properties, pile arrangement information and applied forces and moments for each load condition. Input can be via terminal keyboard as the program requests input in conversational mode; from input data file D29004 saved prior to running this program; from a binary output data file created and saved by program number 713-F5-A2-110 plus terminal keyboard input or from a binary output from 713-F5-A2-110 plus input saved on data file D29004. User has the option of obtaining a printout of all computed pile loads for each load condition; a printout of only the results for the respective critical load condition, or a printout of the maximum allowable pile spacing for each pile row based on the respective critical load conditions.

F. ADDITIONAL REMARKS

Program is limited to two-dimensional applied loading and assumes all piles in the same row carry equal loads. The computation of allowable transverse loads is limited to hinged end piles.

Program is operational and has been tested within above limitations. Mod 5 of program is documented, and a brief description of each of the subsequent modifications has been placed in front of the prior documentation.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM	PROGRAM NO.
Equivalent K for Pile in Stratified Soil System	713-F5-A2-250

PREPARING AGENCY
NOED, Corps of Engineers, P. O. Box 60267, New Orleans, Louisiana 70160

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STATUS OF PROGRAM: STAGE
C. W. Ruckstuhl, Jr.	(OPERATIONAL) Aug 71	ORGIN	Jan 71

A. PURPOSE OF PROGRAM For a pile in a stratified soil system with different known values of moduli of horizontal subgrade reaction (constant and/or varying linearly with depth) compute a single equivalent value of constant modulus of horizontal subgrade reaction, the applied transverse load and moment required to be applied to a fixed pile head to produce a unit transverse deflection of the pile head with no rotation and the applied transverse load and moment required to be applied to a fixed pile head to produce a unit rotation of the pile head with no transverse deflection, or the applied transverse force required to be applied to a hinged pile head to produce a unit transverse deflection of the pile head and the resulting rotation of the pile head.

B. PROGRAM SPECIFICATIONS
The program is written in FORTRAN IV and consists of a main program plus eight overlay segments, each of which contains one or more subroutine subprograms

C. METHODS The pile is divided into segments, one for each soil stratum that has a different value for the subgrade modulus (K). For each stratum that has a variable K, the segment is subdivided into increments and a constant value of K is assigned to each increment, dependent upon its length and the rate of change in K. The effects of a unit transverse force and unit moment applied independently on each end of each increment are computed for each increment acting as a beam on an elastic foundation with free ends. A matrix of these coefficients is established by assembling them into a set of simultaneous equations to compute the moments and shears required to produce continuity across the equations to compute the moments and shears required to produce continuity across the free ends previously assumed for each increment. The matrix is inverted to provide the initial solution for unit loads applied to the pile head. The computed rotations and deflections of the pile head are then converted to the required forces and moments to produce unit displacements of the pile head.

D. EQUIPMENT DETAILS

This program executes in time-sharing mode on the GE-435 computer system at WES via teletype model 33 ASR terminal under user number N609. Binary file name is K29022.

E. INPUT-OUTPUT
Input data consists of control variables, project identification, and the pile and soil properties.
Printed output consists of the program name and number, project identification, a tabulation of the input data, and the final computed values. Varying stages of intermediate answers may be output by means of the initial control variable values.

F. ADDITIONAL REMARKS
Reference is made to "Effect of Different Values of Subgrade Modulus on Laterally Loaded Piles in a Stratified Soil System", a thesis submitted to Tulane University of New Orleans on 23 July 1971 as partial fulfillment of the requirements for a Master's degree by the author of this program.

For additional information, contact C. W. Ruckstuhl, Jr. (504) 865-1121, x-376.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.
Centroid of a Polyhedron			713-F3-A2-100
PREPARING AGENCY			
New Orleans District			
AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STAGE
M. E. Pittman	June 1975	Orig	

A. PURPOSE OF PROGRAM

This program finds the centroid and volume of an arbitrary polyhedron (solid bounded by plane surfaces).

B. PROGRAM SPECIFICATIONS

The program is written in Series 600 time-sharing FORTRAN for the WES G-635 time-sharing system. The program is limited to polyhedra of 200 points and 20 points per face.

C. METHODS

The program splits the polyhedron into positive and negative volumes generated by projecting each face down to the x-y plane. From the equation of the plane face and the area, centroid, and moments of the projection, the volume and centroid of each section can be determined and added to yield the total volume and centroid.

D. EQUIPMENT DETAILS

The program is written for the WES G-635 HIS time-sharing system and is executed from a low speed remote terminal.

E. INPUT-OUTPUT

Input - The input data consists of the number of points defining the polyhedron the points themselves, the maximum number of points per face, the number of faces, and the specific-tion of each face by point numbers (in clockwise order as viewed from outside the ployhedron).

Output - The printed output gives for each face the area, center, and moments of its x-y projection and the volume and centroid of each section. It then gives the total volume of the ployhedron and its centroid.

F. ADDITIONAL REMARKS

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.	
Three-Dimensional Pile Foundation Analysis (K29010)			713-F3-A2-210	
PREPARING AGENCY				
USAED - New Orleans, Corps of Engineers, P.O. Box 60267, New Orleans, LA 70160				
AUTHOR(S)	**DATE PROGRAM COMPLETED**	**STATUS OF PROGRAM**		
		PHASE	**STAGE**	
H. C. Edgecombe, Jr.	(OPERATIONAL) March 1975	MOD 7	Jan 70	

A. PURPOSE OF PROGRAM

The purpose of hte program is to provide a three-dimensional analysis of a pile foundaiton with battered piles.

B. PROGRAM SPECIFICATIONS

The program is written in FORTRAN IV time-sharing language for processing on the WES G-635 time-sharing system. Source file name is A2B00/K293D2, object file is executed in batch mode from a file in the CARDIN time-sharing sub-system or from the use of the appropriate control cards in remote batch.

C. METHODS

The general method of analysis is an expansion to three dimensions (by SAUL) of the Hrennikoff direct stiffness methods for a two-dimensional analysis.

D. EQUIPMENT DETAILS

WES G-635 Computer System with disc files and time-sharing terminal and/or remote job entry terminal.

E. INPUT-OUTPUT

Technical engineering data is entered in data file "D29010".
Output consists of the forces and moments (3 dimensions) on each pile row in the foundation. Summary output is at the terminal, detailed output is on output file "P29010" and may be continued on file "Q29010" for large foundations.

F. ADDITIONAL REMARKS

Original program logic was adapted from the basic program authored by Mr. Mudd in the St. Louis District Office.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.
BEAMS (SHEAR, MOMENT, DEFLECTION)			713-F5-A2-580
PREPARING AGENCY U. S. Army Engineers, New Orleans District P. O. Box 60267, New Orleans, Louisiana 70160			
AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM — PHASE	STATUS OF PROGRAM — STAGE
Dennis J. Beer	April 1971	ORGIN	JAN 71

A. PURPOSE OF PROGRAM

The program will select from a file and/or analyze a symmetrical straight member for any statically determinant one-dimensional load system which consists of transverse point loads, transverse continuous loads, and/or couples. It will calculate the transverse shear force, bending moment, and deflection from a chosen reference line for cross sections of the beam chosen by the program for analysis.

B. PROGRAM SPECIFICATIONS The program is written in FORTRAN IV language for a General Electric 400 Series Time-Sharing System and requires 27,708 (10) words of memory. The program is limited to 50 defining loads of the load system which consists of point loads or continuous loads which act normal to the long axis and in the plane of the member or couples which act perpendicular to this plane. The beam length and the number of point loads and couples is limited by each other as follows: Beam Length (feet) 70-2n where n=number of point loads and couples 35.

C. METHODS After reading in the load system, some physical and geometric properties, and indicators to define the system, the program calculates the statically determinant resultants at the support(s) by statics. It determines the transverse shear force and bending moment at selected appropriate beam cross sections by strength of material principals and statics. The best member to support the load can then be chosen by the program from a list based on the section modulus Deflections of the cross sections along perpendiculars from the unloaded configuration of the beam and from a chosen reference tangent to the deflected beam are then determined by the Moment-Area Method.

D. EQUIPMENT DETAILS

Execution of the program requires a General Electric 400 Series computer linked to a time-sharing system which has disc storage capability.

E. INPUT-OUTPUT Input data consists of the following: indicator values; a job title; the number of external supports; the beam coordinate of the ends of the member at which the analysis is to begin and end, of the reference of the deflection, of the lower end of the concrete wall, and of the point(s) of support; Young's modulus, the factor of safety; and the load system entered as follows for each load: the code of the type of load, member coordinate of application, and the directional magnitude of the load.

F. ADDITIONAL REMARKS Output consists of the following printed data depending on the choice of the user: all data listed for the input less the indicators, the name of the member chosen either by the user or by the program, the physical properties of the member that were used by the program, and a list of beam coordinates of the cross sections chosen for analysis and the corresponding transverse shear force, shear stress, bending moment, and deflection of the member from a chosen tangent to the beam and/or the unloaded configuration of the beam.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM: Beam Deflection	PROGRAM NO.: 713-F5-A2-270

PREPARING AGENCY
NOD, Corps of Engineers, P.O. Box 60267, New Orleans, LA 70160

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STATUS OF PROGRAM: STAGE
D. J. Elguezabal, Jr.	OPER. October 1971	ORIG	Oct. 71

A. PURPOSE OF PROGRAM

To calculate deflections on a beam loaded with one or more loading conditions. Program is set up to calculate the deflections caused by six different types of loading. (See back for list of loading types)

B. PROGRAM SPECIFICATIONS

Program is written in ASA FORTRAN. All input is by direct keyboard typing as the computer asks in conversational mode. There is no limit on the number of loading combinations, but number of points on beam on which to calculate deflection is limited to 200.

C. METHODS

Program uses method of superpositioning, calculates deflections on beam due to one load and adds it to the deflection calculated for the other loading conditions.

D. EQUIPMENT DETAILS

Program is written for use in a GE-435 computer with timesharing via teletype model 33 ASR terminal. Program length is 3807 chars.

E. INPUT-OUTPUT

Input is typed in as the computer asks in conversational mode. Input consists of number of load types, length of beam, number of points on beam, moment of inertia and modulus of elasticity. Load data is input by typing load code number plus data required by code.

F. ADDITIONAL REMARKS

Program is written for easy expansion to include other load types as needed.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM	PROGRAM NO.
Read & Store W Shape Steel Properties	713-G2-A2-280

PREPARING AGENCY

U. S. Army Engineers, NOD, P.O. Box 60267, New Orleans, LA 70160

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STATUS OF PROGRAM: STAGE
Jim Flock	January 1973	Origin	Jan 73

A. PURPOSE OF PROGRAM

The purpose of the program is to read AISC steel column W shape properties and store them on tape.

B. PROGRAM SPECIFICATIONS

The program is written in FORTRAN IV and requires 250 OCTAL words memory.

C. METHODS

Data cards containing the properties for W shape columns (one column per card) are read one at a time, written on BCD tape which is rewound upon completion of the data. This tape is then used as input to the AISC Steel Column Design Program CDA 1-69*.

D. EQUIPMENT DETAILS

Honeywell 415, 16K available
1 Card Reader
1 Magnetic Tape

E. INPUT-OUTPUT

Input - Cards containing column properties taken from the:
MANUAL OF STEEL CONSTRUCTION
7th Edition, American Institute of Steel Construction, Inc.
101 Park Ave., New York 10017

Output - Tape on Unit 2

F. ADDITIONAL REMARKS

*NOTE: The AISC Steel Column Design Program CDA 1-69 was issued August 1970 to users registered with the AISC. See program abstracts in the Programmer's Manual: Computer for Steel Column Design/CDA 1-69, and the User's Manual: Computer Program for Steel Column Design/CDA 1-69 issued with the program.

ID# 4K29001A

St. Louis District

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM	PROGRAM NO.
Matlock's Recursive Solution for Beam Columns	713-F3-A3-500

PREPARING AGENCY
St. Louis District

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STATUS OF PROGRAM: STAGE
Larry Farmer, Univ. of Missouri Revised by Tom Mudd			

A. PURPOSE OF PROGRAM

Analyzes beam column problems and provides answers that approximate classical solutions to similar problems. It analyzes a model consisting of interacting bars and springs and the solution is consistent with the similarity of the model with the problem to be analyzed. It is especially good where conventional analysis would be difficult such as beam on elastic foundation problems, variable moments of inertia problems, spring restraint problems, and critical buckling loads.

B. PROGRAM SPECIFICATIONS

Written in FORTRAN.

C. METHODS

Uses Matlock's Recursive Solution to analyze a large class of beam-column problems.

D. EQUIPMENT DETAILS

Honeywell G-600/6000 TSS.

E. INPUT-OUTPUT

Input - The number, magnitude and position of the loads, the geometry of the beam or column, the allowable slopes or deflections of the members, and the joint restraints.

Output - Consists of values for the maximum deflection, shear, and bending moment at each incremental distance along the beam-column.

F. ADDITIONAL REMARKS

Documentation available from the St. Louis District.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM Matlock's Recursive Solution for Beam Columns with Moving Loads	**PROGRAM NO.** 713-F3-A3-50A
PREPARING AGENCY St. Louis District	

AUTHOR(S)	**DATE PROGRAM COMPLETED**	**STATUS OF PROGRAM** PHASE	STAGE
Larry Farmer, Univ. of Missouri Revised by Joseph P. Hartman			

A. PURPOSE OF PROGRAM

Analyzes beam column with moving loads problems and provides answers that approximate classical solutions to similar problems. It analyzes a model consisting of interacting bars and springs and the solution is consistant with the similarity of the model with the problem to be analyzed. It is especially good where conventional analysis would be difficult such as beam on elastic foundation problems, variable moments of inertia problems, spring restraint problems and critical buckling loads.

B. PROGRAM SPECIFICATIONS

Written in FORTRAN.

C. METHODS

Uses Matlock's Recursive Solution to analyze a large class of beam-column with moving loads problems.

D. EQUIPMENT DETAILS

Honeywell G-600/6000 TSS.

E. INPUT-OUTPUT

Input - The static load system, the moving load system, the beam-column geometry, specified element slopes, and specified joint deflections.

Output - Maximum positive and negative moments, shears, reactions, deflections, and slopes for each element and the load position which causes these maximums.

F. ADDITIONAL REMARKS

Documentation available from the St. Louis District.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM	PROGRAM NO.
Non-Overflow Monolith Stability Analysis	713-F3-A3-400

PREPARING AGENCY			
St. Louis District			
AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STAGE
Kenneth R. Koller Rev. by: Tom Mudd			

A. PURPOSE OF PROGRAM

The purpose is to analyze a one foot slice of a non-overflow monolith for stability, sliding, and base pressures.

B. PROGRAM SPECIFICATIONS

Written in FORTRAN.

C. METHODS

The program computes the location of the resultant, the factor of safety again against sliding along the base and along a horizontal plane through the foundation with and without cross-bed shear, and also the toe and heel pressures. The data required are: (1) dimensions of the structure, (2) earth loads, (3) water elevations for different conditions, and (4) foundation parameters.

D. EQUIPMENT DETAILS

Originally a RCA 301 program converted to a Honeywell G-400 Batch.

E. INPUT-OUTPUT

Card input.

F. ADDITIONAL REMARKS

Documentation available from St. Louis District.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM	PROGRAM NO.
Spillway and Pier Monolith Stability Analysis	713-F3-A3-150

PREPARING AGENCY
St. Louis District

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STATUS OF PROGRAM: STAGE
Kenneth R. Koller Joe Davis			

A. PURPOSE OF PROGRAM

Analysis of a spillway (with ogce wier) and pier monolith.
The analysis may be applied to a spillway monolith alone or a spillway monolith with pier, at the users option.

B. PROGRAM SPECIFICATIONS

Written in CARD FORTRAN.

C. METHODS

The program computes the dead load and dead moment (about the heel) of the spillway and pier from their respective geometries. It analyzes the spillway for overturning and sliding stability with the following conditions:
(a) construction condition with and without earthquake, (b) normal operating conditions with and without earthquake, (c) induced surcharge condition, and (d) flood discharge condition.

D. EQUIPMENT DETAILS

Originally written for RCA 301 and converted to Honeywell G-400 Batch.

E. INPUT-OUTPUT

F. ADDITIONAL REMARKS

Documentation available from St. Louis District.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM	PROGRAM NO.
Theoretical Section of Non-Overflow Monolith	713-R3-A3-090

PREPARING AGENCY
St. Louis District

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STATUS OF PROGRAM: STAGE
K. R. Koller S. A. Williams			

A. PURPOSE OF PROGRAM

The program is designed to determine a theoretical profile for a non-overflow monolith of a concrete gravity dam. It computes the theoretical section, a section that is stable and is safe against sliding, and a practical section can be determined from the results.

B. PROGRAM SPECIFICATIONS

Written in CARD FORTRAN.

C. METHODS

The program is written in accordance with Gravity Dam Design Manual EM 1110-2-2200, for the following loading conditions: (a) construction condition, (b) normal operating condition (water at top of closed gate), (c) spillway design flood condition, (d) construction condition with earthquake, (e) normal operating condition with earthquake. The results obtained are the dimensions of the section; the summation of moments, horizontal forces, and vertical forces; the position of the resultant, the factor of safety against sliding, the sliding factor SUMH/SUMV.

D. EQUIPMENT DETAILS

Originally RCA 301 converted to Honeywell G-400 Batch.

E. INPUT-OUTPUT

F. ADDITIONAL REMARKS

Documentation available from St. Louis District.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM Indeterminate Pile Analysis - 3-Dimension by Matrix Method	PROGRAM NO. 713-F1-A3-840
PREPARING AGENCY St. Louis District	

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STAGE
Tom Mudd			

A. PURPOSE OF PROGRAM

A general method of analysis by direct stiffness of three-dimensional pile foundations.

B. PROGRAM SPECIFICATIONS

Written in FORTRAN IV.

C. METHODS

The pile foundation consists of a group of piling placed into the soil and topped with a rigid cap. Loads to the cap are transmitted by the pilings to the soil. Determinations of deflections and individual pile loads are computed as required by the designer. Adequate representation of the soil-pile interaction is necessary.

D. EQUIPMENT DETAILS

Honeywell G-635 TSS or Batch.

E. INPUT-OUTPUT

F. ADDITIONAL REMARKS

Documentation is available from St. Louis District.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM Shears and Moments in a Pile Founded Slab	PROGRAM NO. 713-F3-A3-900

PREPARING AGENCY
St. Louis District

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM — PHASE	STAGE
Carlton Smith			

A. PURPOSE OF PROGRAM

This program uses pile forces, and output from the Indeterminate Pile Analysis Program (713-F1-A3-840) to calculate slab shears and moments.

B. PROGRAM SPECIFICATIONS

Written in CARD FORTRAN

C. METHODS

D. EQUIPMENT DETAILS

Honeywell G-600/6000 Batch

E. INPUT-OUTPUT

Input - Pile coordinates and line and dead slab loads.

F. ADDITIONAL REMARKS

Partial
Documentation available from St. Louis District.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM Structural Analysis of Concrete U-Frame Lock on Piles	PROGRAM NO. 713-F3-A3-910
PREPARING AGENCY St. Louis District, Lower Mississippi Valley Division	

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM	
		PHASE	STAGE
Edward Demsky			

A. PURPOSE OF PROGRAM

This program performs an analysis of a two-dimensional concrete U-frame lock on piles driven in sand.

B. PROGRAM SPECIFICATIONS

Written in FORTRAN.

C. METHODS

The program uses the direct stiffness method of analysis. The stiffness matrix of individual piles and U-frame elements is calculated and then assembled into a stiffness matrix for the whole structure. The pile stiffness matrix is based on the Hrennikoff Method.

D. EQUIPMENT DETAILS

Honeywell G-600/6000 TSS.

E. INPUT-OUTPUT

F. ADDITIONAL REMARKS

Documentation available from St. Louis District.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.
Computation of Forces on Tainter Gate and Trunnion Pin			713-G1-A3-110

PREPARING AGENCY
St. Louis District

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STATUS OF PROGRAM: STAGE
Jon W. Eckles			

A. PURPOSE OF PROGRAM

The program performs a static analysis of a tainter gate assembly.

B. PROGRAM SPECIFICATIONS

Written in CARD FORTRAN.

C. METHODS

A static analysis of a tainter gate assembly accounting for various forces encountered in its operation. The system includes, besides the gate itself, the trunnion pin upon which the gate pivots, and a hoist and cable assembly attached to the front of the gate.

D. EQUIPMENT DETAILS

Honeywell G-600 Batch.

E. INPUT-OUTPUT

F. ADDITIONAL REMARKS

Documentation available from St. Louis District.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.
Cantilever Retaining Wall Stability Design			713-R1-A3-440
PREPARING AGENCY			
St. Louis District			
AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM	
		PHASE	STAGE
Arthur Johnson & James Worts Rev. by: Jon Eckles and Gerald Schwalbe			

A. PURPOSE OF PROGRAM

The purpose is to design a one (1) foot section of a cantilever retaining wall as outlined in EM 1110-2-2502.

B. PROGRAM SPECIFICATIONS

Written in FORTRAN.

C. METHODS The program allows for various water elevations on either side of the wall; earthquake forces; uniform surcharge and/or Boussinesq wheel load surcharge on the landside backfill; different horizontal fill levels on the riverside. The landside backfill may be sloped up or down, flat, or a combination of both with the flat portion next to the wall.

The width of the stem is designed by two requirements.

1. To resist the moments applied by the loads at the base.
2. To resist the shear at a D-distance above the base.

This stem base width is then used as the base thickness.

The base width is designed for given toe widths by three criteria.

1. The position of the resultant must fall within a specified portion of the base.
2. A specified sliding factor of safety must be maintained.
3. The allowable foundation pressure must not be exceeded.

The result is a minimum base width for a given toe width which meets all conditions specified.

D. EQUIPMENT DETAILS

Honeywell G-635.

E. INPUT-OUTPUT

Input - Card.

F. ADDITIONAL REMARKS

Documentation available from St. Louis District.

AD-A031 246 ARMY FOREIGN SCIENCE AND TECHNOLOGY CENTER CHARLOTTE--ETC F/G 9/2
CORPS-WIDE CONFERENCE ON COMPUTER-AIDED DESIGN IN STRUCTURAL EN--ETC(U)
AUG 76 R M WAMSLEY, F J BOURGEOIS, D DRESSLER

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ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM	PROGRAM NO.
Boussinesq Surcharge Pressures on Retaining Walls	713-R1-A3-690

PREPARING AGENCY
St. Louis District

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STATUS OF PROGRAM: STAGE
Joseph Davis Revised by: Joseph Reynolds & Gerald Schwalbe			

A. PURPOSE OF PROGRAM

This program was written to provide the incremental and resultant pressures and moment arms acting on the stem and heel of retaining walls.

B. PROGRAM SPECIFICATIONS

Written in CARD FORTRAN

C. METHODS

D. EQUIPMENT DETAILS

Written originally for the RCA-301 but has been modified to run on the Honeywell G-635 in a batch mode.

E. INPUT-OUTPUT

F. ADDITIONAL REMARKS

Documentation available from St. Louis District.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM: Cantilever Retaining Wall Stability Analysis and Final Design	PROGRAM NO.: 713-R1-A3-450

PREPARING AGENCY
St. Louis District

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STAGE
Arthur Johnson and James Worts Rev. by: Gerald Schwalbe & Jon Eckles			

A. PURPOSE OF PROGRAM

The purpose is to analyze a one foot slice of a cantilever retaining wall for stability and to design the area of steel required at different points in the stem, heel, and toe. The dimensions of the structure to be analyzed are determined by the program "Cantilever Retaining Wall Stability Analysis" (713-F1-A3-440) or by an existing structure.

B. PROGRAM SPECIFICATIONS

Written in CARD FORTRAN.

C. METHODS

Computes the forces and moments acting on the stem, finds the D-distance required by moment and shear on the stem and computes the forces and moments on the entire wall. Then it finds the position of the resultant, toe pressure, heel pressure, and sliding factor of safety for each loading case. It then computes the D - requried by moment, the maximum D-distance possible based on the width of the member, the amount of steel required, the shear, shear stress and allowable shear stress for any practical number of increments of the stem, heel and toe up to 17. Finds minimum thickness of heel and toe to the nearest .25ft.

D. EQUIPMENT DETAILS

Honeywell G-635 Batch.

E. INPUT-OUTPUT

Allowables and actual values are checked against each other throughout the program especially on shear requirements as these are not normally design criteria but checks. Messages are printed out if the requirements are not met.

F. ADDITIONAL REMARKS

Documentation is available from St. Louis District

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.
Indeterminate Pile Analysis - 3-Dimension by Matrix Method			713-F1-A3-840
PREPARING AGENCY			
St. Louis District			
AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM — PHASE	STAGE
Tom Mudd			

A. PURPOSE OF PROGRAM

A general method of analysis by direct stiffness of three-dimensional pile foundations.

B. PROGRAM SPECIFICATIONS

Written in FORTRAN IV.

C. METHODS

The pile foundation consists of a group of piling placed into the soil and topped with a rigid cap. Loads to the cap are transmitted by the pilings to the soil. Determinations of deflections and individual pile loads are computed as required by the designer. Adequate representation of the soil-pile interaction is necessary.

D. EQUIPMENT DETAILS

Honeywell G-635 TSS or Batch.

E. INPUT-OUTPUT

F. ADDITIONAL REMARKS

Documentation is available from St. Louis District.

Vicksburg District

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM Box Culvert Design - One Cell	PROGRAM NO. 713-G9-A4060

PREPARING AGENCY
U. S. Army Engineer District, Vicksburg

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STAGE
Walter T. Miller and Richard C. Davis	May 1971		

A. PURPOSE OF PROGRAM

To determine the minimum thicknesses of the horizontal and vertical members and the area of reinforcing steel to provide for moment and the required factor of safety for cracking load for shear.

B. PROGRAM SPECIFICATIONS

For a maximum of thirty loading conditions the program will find the minimum thicknesses required to support the load or it will compute the resulting stresses, d's, steel reinforcing and factor of safety in the members. The program does not compute for haunches. Backfill is considered to be level over the completed structure.

C. METHODS

The design is in accordance with the criteria set forth in EM 1110-2-2902. Distributed moments are adjusted to the column face and at the center of the span by the method explained starting on page 28 of Continuity in Concrete Building Frames, Practical Analysis for Vertical Load and Wind Pressure, fourth edition, published by the Portland Cement Association.

D. EQUIPMENT DETAILS

The program is written in FORTRAN IV for GE 400 Series computers.

E. INPUT-OUTPUT

Input consists of 6 types of cards in the following sequence:

(1) User ID. One time only.
(2) Title card. One per culvert.
(3) Comment card. Optional.
(4) Constants. One per culvert.
(5) Case title. One per case.
(6) Case data. One per case.

The input setup should include as many pairs of case title and case data cards as there are loading conditions.

Output consists of:

(1) Recap of input and thicknesses of members.
(2) Adjusted moments, thrust, and shears for external, internal, and hydrostatic head loadings.
(3) Maximum shear, maximum moment, thrust for load producing maximum moment, Nd"/12, steel moment, required d's, provided d's, equivalent areas of steel, equivalent areas of thrust and the areas of steel reinforcing for each of the seven points inspected.
(4) For horizontal members the resulting safety factor for cracking load, safety factor required, and the distance between points of contraflexure for both maximum and external loading.
(5) The above information is given for either one or two factors that control vertical soil loading for each case. At the end of the design analysis a summary sheet gives the maximum thickness required in each member, maximum steel area for reinforcing at each design location, range of contraflexure in each horizontal member and cross-sectional area of concrete.

F. ADDITIONAL REMARKS

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.
Computer-Aided Design of Horizontally Framed Miter Gates			713-F3-R0-020
PREPARING AGENCY U. S. Army Engineer Waterways Experiment Station, Automatic Data Processing Center, P. O. 631, Vicksburg, Miss. 39180			
AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STAGE
William L. Boyt	Nov 1975	Final	Operational

A. PURPOSE OF PROGRAM

This FORTRAN IV program and the data preparation and output have been prepared with one basic philosophy--to enable the design engineer to obtain a meaningful solution to his problem in the most logical and straight-forward manner, while keeping the required input data simple and minimal.

B. PROGRAM SPECIFICATIONS

Data requirements and procedures are described and presented for using MITER--an interactive computer-aided engineering design program. MITER can consider the following items and their influence on the design of horizontally framed gates having a miter angle of 1 on 3: (a) intercostals; (b) horizontal girders; (c) tapered end sections; and (d) vertical diaphragms. The "try it and see" philosophy incorporated in the program makes it ideal for use by the design engineer as a natural extension of his established design procedure.

Interactive input/output, using the Honeywell G-635 time-sharing (T/S) computer system, is achieved between the user and MITER. This interaction allows the design engineer to choose a certain load on a group of girders, or a skin plate thickness, or a certain size stiffener in a girder section, and then let MITER calculate and print the loads, stresses, and moments resulting from that choice. The MITER restart capability is important to the design engineer; it enables him to stop the computation at one of several major points (checkpoints) in the design process. He may subsequently return to the computer and continue the design analysis by beginning with results obtained at the last checkpoint (i.e., can start again where he left off). This feature frees him from the necessity (and attendant pressure) of completing the entire design at one session at the terminal. Thus, problems caused by interruptions, computer failure, and the cost of "thinking time" while at the terminal can usually be ignored. Checkpoints having restart capability are: (a) skin plate design, (b) intercostal design, (c) girder loadings, (d) section design, (e) completion of all section designs, and (f) tapered end section. A detailed explanation of computational methods used in the program, data preparation information, procedures for use in executing the program, and an example problem--with output--are presented.

C. METHODS

Design criteria outlined in paragraph 9 of EM 1110-1-2101 (1 November 1963): Engineer Manual - Working Stresses for Structural Design.

D. EQUIPMENT DETAILS

Honeywell G-635 Time-Sharing Computer System.

E. INPUT-OUTPUT

Input is through a data file, entered on-line at the TTY as directed by the program. Output is at the TTY, in a data file in a format suitable for inclusion in a design memorandum.

F. ADDITIONAL REMARKS

Report available: "Computer-Aided Design of Horizontally Framed Miter Gates" - W. L. Boyt, MP K-75-9, Nov 1975, U. S. Army Engineer Waterways Experiment Station, Vicksburg, MS 39180

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM	PROGRAM NO.
Two-Dimensional Non-Orthogonal Plane Frame Analysis	713-F3-A4140

PREPARING AGENCY
U.S. Army Engineer District, Vicksburg, Mississippi

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STATUS OF PROGRAM: STAGE
Charles M. Hargett	July 1969		Operational

A. PURPOSE OF PROGRAM

This program is designed to analyze plane frames or continuous beams taking into account bending and axial deformation. The program computes joint rotations and displacements and axial loads, shears and moments for each member.

B. PROGRAM SPECIFICATIONS

This program is written in FORTRAN IV.

C. METHODS

Analysis is by the stiffness method based on the slope deflection method. Solution is by way of a set of simultaneous equations expressed in matrix form, defining the structure stiffness matrix, the joint displacement matrix and the joint load matrix. See attached Electronic Computer Abstract, title as above, dated July 1969.

D. EQUIPMENT DETAILS

This program is currently being processed on a G-437 computer.

E. INPUT-OUTPUT

Input is by cards.
Output is on printer paper from output tape.

F. ADDITIONAL REMARKS

Any geometry or loading arrangement may be specified with the exception that all members are assumed prismatic between joints.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.
Lock Culvert Frame Analysis (CULVERT)			713-F3-RO-017
PREPARING AGENCY: USAE Waterways Experiment Station, P. O. Box 631, Vicksburg, Ms. 39180			
AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STAGE
P. K. Senter F. T. Tracy	September, 1971		OP

A. PURPOSE OF PROGRAM

This program calculates the shears and bending moments at the joints of the frame encompassing the side culvert in a lock wall of a dam.

B. PROGRAM SPECIFICATIONS

This is a time-sharing program written in Honeywell Series 600/6000 FORTRAN. Both fixed and floating point arithmetic is used. If the span/depth ratio of the frame members becomes small, the results may not be accurate.

C. METHODS The program assumes a u-frame lock with symmetric loading (equal earth fill on each side of the lock). The lock culvert is treated as being composed of four members which act as a group like a frame. Any of the individual members may have a varying depth along its length. The moment distribution nethod of frame analysis is used in the program. This is a standard frame analysis method for frames which are composed of members of large span/depth ratios.

D. EQUIPMENT DETAILS

Honeywell G-635 computer with time-sharing capabilities.

E. INPUT-OUTPUT

The data is input via a time-sharing terminal and is read by the program from a disc file. The output may be received at the terminal or from an accessible line printer.

F. ADDITIONAL REMARKS

Documentation of the program is contained in the Waterways Experiment Station Miscellaneous Paper K-73-5, dated June 1973.

Appendix B: Excerpts from Monolith Studies

Par 4-03

4-03. NONOVERFLOW MONOLITHS

a. General. Details of the nonoverflow monoliths are shown on PLATES 21 and 22. A summary of the loading conditions and stability analyses has been presented on CHARTS 4-3-1 through 4-3-42. The design of the left nonoverflow monoliths D1 through D6 are presented first, followed by those studies made of the right abutment monoliths D13 through D17.

b. Description. Nonoverflow monoliths will be provided to the left of the powerhouse from stations 8+00.75 to 9+85.75 and to the right of the spillway from stations 1+35 to 3+00 along the axis of the dam. The right abutment monolith D11-12 fills the gap between station 3+00 and the face of the spillway pier at station 3+60. Design of monolith D11-12 is covered in paragraph 4-04.

c. Design Criteria.

(1) General. The shear strengths listed in paragraph 4-02b(2) were used in the stability design of the nonoverflow monoliths. The parameters listed for limestone apply to both the shear properties along a concrete to rock contact as well as the inclined plane of a passive wedge within the limestone formation. Those parameters listed for shale were used in various combinations to bracket a range of sliding factors of safety. Earthquake conditions were considered abnormal loading and for these cases the resultant was allowed to fall outside the kern but within the base. All other conditions were considered normal and the resultant was not allowed to fall outside the kern. The sliding factor of safety requirement was held at 4.0 for all conditions studied for the limestone-founded monoliths and was varied for the shale-founded structures depending on the loading condition and the shear strength combinations. These will be discussed in paragraph 4-03e, Right Abutment. Allowable bearing pressures for the founding materials were as listed in paragraph 4-02b(4).

(2) Computer Programs. Two computer programs developed by this District were used in the design of the nonoverflow monoliths. They are:

(a) Program 713-R1A3-090. This program computes a theoretical section for the nonoverflow monoliths of the dam. The program is written in accordance with EM 1110-2-2200, "Gravity Dam Design," and the section computed is stable and safe against sliding for the loading conditions listed on CHART 4-3-1. It follows the procedure outlined in Engineering for Dams (Volume II) by Creager, Justin, and Hinds. The loads are computed in a conventional manner. Vertical loads due to concrete, water, and embankment are simply unit weight

times volume. Earthquake and horizontal water loads are computed as discussed in paragraph 4-02c. Uplift is computed assuming the drains to be 50 percent effective.

(b) Program 713-R1A3-400. This program computes the location of the resultant, heel and toe pressures, and the factor of safety against sliding along the concrete-rock contact at the monolith base and along a horizontal plane through the rock at the elevation of the heel of the monolith. The program computes a sliding factor of safety for both these planes with and without a passive wedge. Resistance to sliding along the base (Plane A) and along the horizontal plane through the rock at the same elevation as the heel (Plane B) without crossbed shear is computed as $S_{s-f} = \frac{f\Sigma.V + CL}{\Sigma H}$. These factors have previously been defined in paragraph 4-02d(1). Resistance to sliding with crossbed shear assumes passive resistance to develop in the downstream rock, and is computed for Planes A and B for all loading conditions except the construction condition and construction condition with earthquake. The theoretical resistance offered by the passive wedge is added to the numerator of the above equation to find S_{s-f} as shown in paragraph 4-02d(1). Earthquake concrete loads are calculated as the weight of the section times the ratio of earthquake acceleration to gravity. Earthquake embankment loads are taken as a fraction of horizontal earth pressure, both on the upstream and downstream sides of the monolith and acting opposite to the direction of the acceleration. Water pressure has the usual triangular loading. Soil pressure is taken as an equivalent fluid pressure determined by a supplied soil coefficient adjusted for slope of the backfill. These coefficients are given in paragraph 4-02b(3). The height of earth used is from the top of the fill to the top of rock or to the top of the stepped portion of the concrete monolith, whichever is at the lowest elevation. The resultant of the horizontal soil pressure is applied at the third point of the height. "B" given on CHART 4-2-2 was used as 90 degrees both upstream and downstream. The depth and pressure of ice is supplied in the input, and wind load is taken as a uniform load of 30 p.s.f. over the downstream face above natural ground level. Uplift is computed in the manner described in EM 1110-2-2200 for the case with foundation drains. Uplift pressures for a sloping base include the difference in head due to the slope of the base. CHARTS 4-3-3 through 4-3-14 show the loads calculated by the computer for all of the loading conditions analyzed for monolith D1.

d. Left Abutment.

(1) Monoliths D1 through D6 were analyzed using the computer programs discussed in paragraph 4-03c(2). Fill heights against the monoliths vary as shown on PLATE 20. All monoliths were designed assuming at-rest soil pressures with at-rest pressure coefficients

adjusted for negative backfill slopes. All monoliths are founded on limestone at elevation 465.0 and are safe against sliding without a passive wedge. Monoliths are grouped in pairs: D1 and D2; D3 and D4; and D5 and D6. Base widths are 103 feet, 120 feet, and 132 feet, respectively. All monoliths are 30 feet long except D1 which is...

4-05. OVERFLOW MONOLITHS

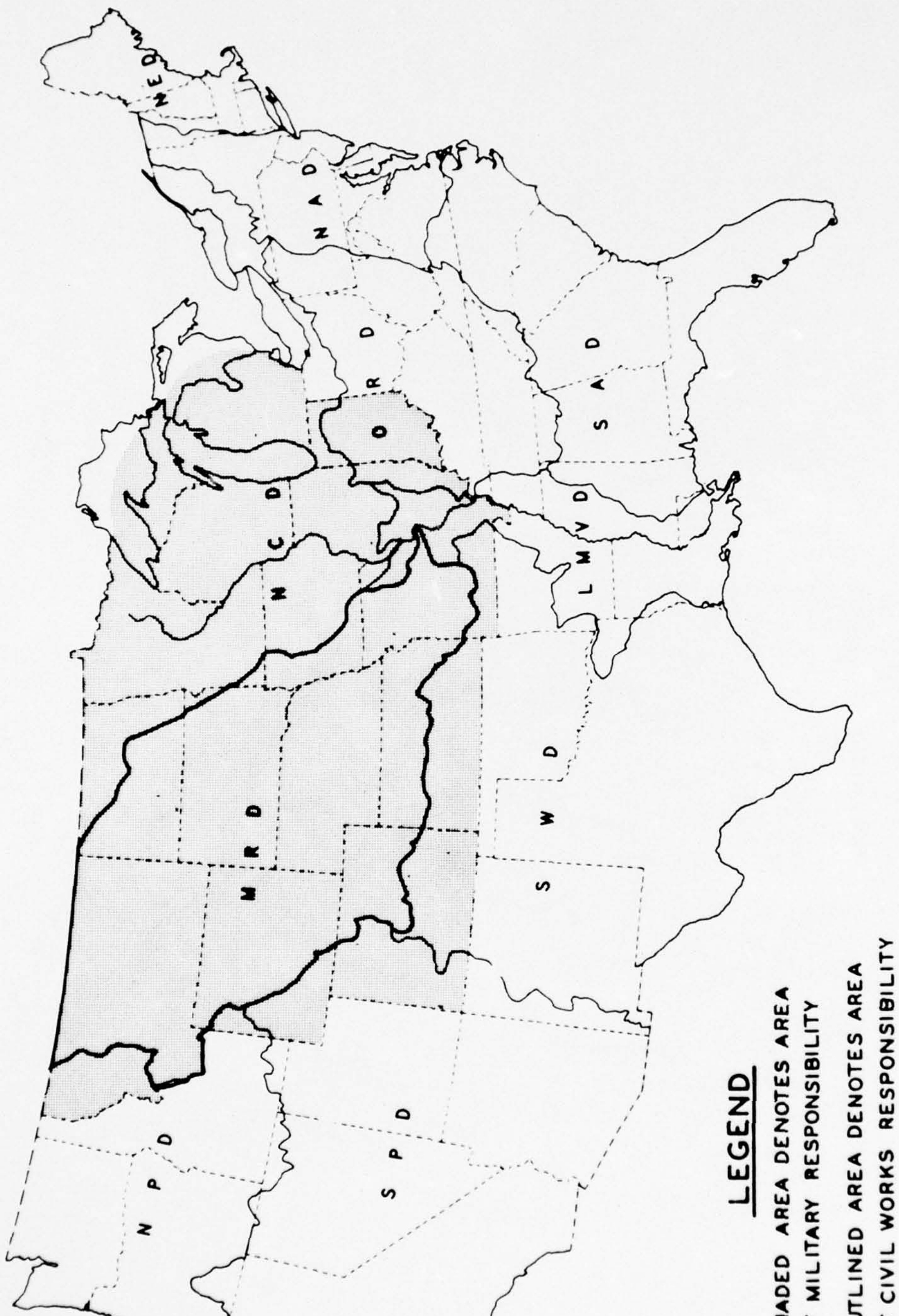
a. General. Details of the concrete overflow monoliths are shown on PLATE 28. A summary of the loading conditions and stability analyses has been presented on CHARTS 4-5-1 through 4-5-15.

b. Description. The base of the overflow monoliths are horizontal and founded on limestone at elevation 465.0. Monoliths D8, D9, and D10 consist of a 10-foot-wide pier, with half of a 50-foot-wide gate bay on either side for a total width of 60 feet. Monolith D7 has a width of 25 feet. Gate loads for monolith D7 are transmitted into the powerhouse and monolith D8. All of the overflow monoliths have a 6-foot by 8-foot gallery; centerline gallery is located 28'3" upstream of the axis of dam with a floor elevation of 473.0. It was determined that a base length of 155 feet for monolith D7 and 150 feet for monoliths D8, D9, and D10 was required for stability.

c. Design Criteria. The overflow monoliths were designed as concrete gravity structures in accordance with EM 1110-2-2200, "Gravity Dam Design," 25 September 1958 and subsequent ETL 1110-2-63, 25 June 1969. Uplift was assumed at the toe equal to tailwater, and at the heel equal to tailwater plus 50 percent of the difference between headwater and tailwater. As discussed in paragraph 4-02d(1), only those loading conditions involving earthquake were considered as "abnormal." All others were considered "normal." The resultant was allowed to fall outside the kern for the "abnormal" conditions and was required to fall within the kern for all "normal" loading cases. The required sliding factor of safety for both "normal" and "abnormal" loading conditions was 4.0. Sliding on the limestone was computed using the formula discussed in paragraph 4-02d(1). St. Louis District Program No. 713-R1A3-150, Spillway and Pier Monolith Stability Analysis was used in the analysis of these monoliths.

d. Summary. The location of the resultant for the design flood loading conditon governed the selection of the base dimensions. Neither the sliding factor of safety nor the bearing capacity was critical for the structure configuration. The minimum sliding factor of safety was 6.1 and occurs under the normal operating with earthquake condition. The maximum foundation pressure is 24.0 KSF and occurred under the same loading condition.

THE MISSOURI RIVER DIVISION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LEGEND
SHADED AREA DENOTES AREA OF MILITARY RESPONSIBILITY
OUTLINED AREA DENOTES AREA OF CIVIL WORKS RESPONSIBILITY

THE MISSOURI RIVER DIVISION

by

Robert J. Hunt*

Introduction of Missouri River Division

The Missouri River Division (MRD) is the largest division in area within CONUS. We work throughout this 13-state area meeting our military construction responsibilities. For comparison purposes, this is equal to the territory occupied by France, Italy, Spain, Portugal, Sweden, Norway, and both Germanies. The civil and military programs are performed by two District Offices--one in Omaha and one in Kansas City. The Division Office is also located in Omaha.

Our military construction includes support for huge Army posts and Air Force bases, exotic missile launching and control facilities, and many special-purpose facilities for both services. One of our most notable projects has been construction of NORAD Headquarters--the city within a mountain--built inside Cheyenne Mountain in Colorado.

Our Civil Works area covers the drainage basin for the entire Missouri River from its origin near Three Forks, Montana, down 2315 river miles to its confluence with the Mississippi just north of St. Louis. The six main-stem hydropower dams constructed by MRD to tame the Missouri are Fort Peck, Garrison, Oahe, Big Bend, Fort Randall, and Gavins Point. The effectiveness of these dams was dramatically illustrated this spring and summer. The 1935 flood season runoff was about twice that of normal and produced a record volume of 73 million acre-ft of storage at the peak. The runoff on the upper Missouri surpassed any previous runoff since records began in 1898. The reservoirs and channels are still brim-full, with more than 71 million acre-ft of water. We in MRD are proud to be part of the Corps when our projects prove to be so effective in preventing what would have been a major flood in the Missouri Valley.

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* Chief of Automatic Data Processing, Missouri River Division.

Also included in the Civil Works area are the Kansas and Osage River basins. These include a number of attractive, medium-size multi-purpose flood-control and recreation projects. Two of these have hydro-power; they are the Stockton Hydropower Dam and the Harry S. Truman pump-back storage hydropower installation (under construction).

Computer Facilities in MRD

As early as 1958, engineers of the Omaha and Kansas City Districts were developing structural design programs for their use. The early computers, such as the Burroughs E102, were cumbersome to work with. Very little storage was provided--220 words for the Burroughs compared with 60,000 words of storage used by many of our programs on the CDC 7600 today. Hundreds of cards or punched paper tapes were required. Print-outs were usually by typewriter or cards and were restricted to numbers alone to conserve storage. Usually, only the author of the program was capable of translating the output. Much of the engineer programmer's time was spent trying to trick the small computer into performing a bigger job. However, even with the difficulties in earlier computer usage, much of the drudgery in some areas of design could be eliminated. Computer design resulted in man-hours saved, more accurate computations, some standardization of output, and more complete designs due to the greater number of studies that could be made in a short period of time. The computer method of design analysis, therefore, meant a greater efficiency and reliability at less cost. We have upgraded our in-house computers several times within the Division in an attempt to solve the problems created by a computer that was too small and overloaded.

MRD's medium scale computer, the Honeywell G-437, helps engineers solve some of their structural design problems. This equipment is again overloaded with business type work. We believe we have finally solved the overload and undersize problems by the use of remote batch and time-sharing terminals which allow our engineers to use very large systems via the telephone network. Currently we are using six different large-scale computers located throughout the country by the use of 2-Data

100 Remote Batch Terminals and a number of smaller time-sharing terminals. We feel that the use of contract service gives us flexibility in meeting peak work loads and rapid use of new technology that could never be possible with 100% in-house computer service.

Structural Engineering Programs Recently Used

The Omaha District's programs

(1) "Retaining Wall Design."

(2) "Moment Distribution--Multi-Story Frame."

(3) "PCA Airport Pavement Design."

(4) "PCA Prestressed Bridge Design."

(5) "Steel Column Design."

(6) "Cantilever Sheet Pile."

(7) "2-D Frame and 2-D Frame Combined Load Cases."

(8) "Moment Distribution."

(9) "T-Flood Wall."

(10) "Multi-Cell Box Culvert."

(11) "Box Culvert Moments and Shears."

(12) "Voussior Conduit Design."

(13) "Vanderbilt Frame."

(14) "Stability of Rigid Structures."

(15) "Finite Element Method in Structural Analysis."

(16) "Axisymmetric Solids."

(17) "I-Wall Analysis, Four Soil Zones."

The Kansas City District's programs

(1) "The Analysis of Continuous Beams for Highway Bridges" provides a complete analysis of a continuous beam for a highway bridge and reports the moments, stresses, shears, reactions, deflections, and shear connector spacings produced by dead loads and by standard highway live loads including special military loading and sidewalk live loads defined by AASHTO Standard Specifications. Fatigue stresses are included in the analysis based on the loading (stress) cycles assumed. Input data for this program are minimal. Program data are stored on tape at Berkeley, California. Actual time used on the CDC 6600 computer to

run a typical program is approximately 1 sec. This program eliminates a voluminous amount of tedious calculations such as moments of inertia for various composite girder sections.

(2) "Biaxial Bending" is an elastic analysis of rectangular reinforced concrete members such as "hammerhead" bridge piers.

(3) "One Celled Reinforced Concrete Box."

(4) "Deflections. Cantilever and single span" determines deflection of hinges on continuous-span bridges and service bridges.

(5) "Reinforced Concrete Pipe Design."

(6) "Floodwall Stability Analysis for Design of Inverted T-Walls."

(7) "Working stress review" for analysis of a beam or column using working stress methods. (Also included in the conduit and retaining wall programs.)

(8) "Ultimate Strength Design and Review" reviews or designs beam or column using ultimate strength methods. (Also included in the conduit and retaining wall program.)

(9) "Stilling Basin Uplift."

(10) "Intake Tower Stability."

(11) "Hydraulic Uplift Forces on Gates."

(12) "Two Dimensional Frame Analysis Using Matrix Methods."

Special mention should be made of two Kansas City District programs that are well documented and heavily used.

(1) "The Wall" program is capable of design analysis or review of T-walls, U-walls, and gravity walls.

(2) The other, a program for "Design or Review of Concrete Conduits," calculates the required concrete thickness, the internal stresses and stability, and the required reinforcement. The design or review considers both ultimate strength and working stress methods. The program is capable of generating its own design loading as fill and water loads vary over the length of the conduit. The Kansas City District's wall and conduit programs are the most complete of their type of which we are aware. On several occasions, other Districts or Divisions have contracted with the Kansas City District to use these programs.

Computer-Oriented Procedures at MRD

How does this division disseminate information about programs?

In the past, our abstract programs that were well documented were submitted to Office, Chief of Engineers (OCE) through ADP channels and published in the old OCE abstract list. This list has been discontinued. We have submitted a few programs to the Engineering Computer Programs Library (ECPL) at U. S. Army Engineer Waterways Experiment Station (WES). A number of the programs developed within MRD are well known throughout the Corps and other engineering organizations. This is due to their having been on the old abstract list and information by word of mouth. These programs and documentations have been furnished to many other Districts, government organizations, foreign governments, etc., upon request. Many of the programs were never submitted to OCE in any form since the developers did not have the time or money to complete the documentation. Improvement in the area of exchange of programs is obviously needed. We hope that this conference will provide the solution to this problem.

How new developments are started.

It has been our practice to examine different structural problems for their adaptability to computer programming. When we determine that a computer program would be helpful in solving a structural problem, a search is made of all known lists of computer programs available including ECPL and various vendors of software offerings. Telephone calls are made to OCE and others throughout the Corps known to be knowledgeable in the particular problem. If this search does not turn up a suitable program, one may be developed as time, manpower, and money will permit.

The program writing is usually assigned to younger, less experienced engineers under direction of experienced engineers so that they may learn to use the computer during the process of development. In addition, our engineers are periodically trained to use the latest computer techniques at training courses offered at WES and at universities.

In the past, we did develop a large number of special-purpose structural programs completely with our own resources. We have learned that a really useful program is very expensive to develop. We find that seldom is in-house development from scratch justified; most of our new structural applications are, at least, only modifications of the work of others.

Design improvements.

The computer enables our designers to accomplish their designs faster and more accurately. Many more cases and conditions may conveniently be considered. The sophisticated methods of analysis, such as the finite element method, could not have come into use without the aid of the computer.

Updating programs.

The various lists of current programs must be periodically updated. Computers and methods are continually changing, making it necessary to update or delete obsolete programs. The old OCE abstract developed a very bad reputation because trivial or obsolete programs were not deleted.

Areas of structural design needing computer programs.

At this time, we are not aware of any areas in structural work that are to be done in our Division work load requiring new computer programs. To be sure, when we complete this conference, we will have received a multitude of ideas for updating the programs we now have. Better yet, we will be motivated toward the development of a process of dissemination and/or centralization that will put all the Corps structural engineers back on common ground.

More Effective Use of Computers for Structural Design

The questions that arise are: How can we make computer design easy to use? How can we reduce the time-consuming task of preparing programs? How can we justify the cost of preparation and periodic upgrading of programs for the design of items that are only occasionally

required? Rather than try to develop and maintain expertise in all phases of structural engineering, can we exchange services with experts in other Districts or laboratories?

The answer, we feel, may be in centralization by establishing specified organizations as computer experts in the design of specific items. The applications to be programmed would be assigned by OCE based upon projected needs throughout the Corps.

The type of program (special purpose or general) and structural area would be assigned based upon a cost effective development versus required use analysis determined from a projection of firm Corps-wide work load over the next 5 to 10 yr. Only OCE would be in a position to direct such an effort. We must not be tempted to invest this effort depending just upon the special interest of those selected to do the work.

The organization selected would be funded to write, maintain, and document programs and prepare user manuals. A good user manual may be all the training necessary to use most special-purpose programs. Sophisticated general purpose programs may require training courses. The developers would provide the training when requested on a cost-reimbursable basis. Information regarding these OCE "recommended" programs should be communicated to the field through the "Engineering Manuals" or other engineering channels of communication available to OCE.

Appendix A: Abstracts of Missouri River Division Structural Engineering Computer Programs

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM				PROGRAM NO.
Circular and Oblong Conduit Design				713-F5-C1-01B
PREPARING AGENCY				
Kansas City District				
AUTHOR(S)		**DATE PROGRAM COMPLETED**	**STATUS OF PROGRAM** PHASE	STAGE
Marion M. Harter Byron E. Bircher	James L. Goering	January 1968	Init	Rep

A. PURPOSE OF PROGRAM

This program will perform a design or review analysis for any given sized circular or oblong conduit. The conduit loads, geometry, structural and stress (working and ultimate strength) analysis with either uniform or triangular base pressure are computed by the program. In addition to reinforcement requirements, the program will determine the minimum conduit wall thickness.

B. PROGRAM SPECIFICATIONS

FORTRAN IV.

C. METHODS

Draft to EM 1110-2-2902, dated 1966. (ACI 318-63) Building Code.

D. EQUIPMENT DETAILS

The data processing system is a G-225 terminal to a G-437 Central Processor with the following on-line equipment: card reader, 4-reel magnetic tape unit, and printer.

E. INPUT-OUTPUT

Input is on cards

Output is by the printer.

F. ADDITIONAL REMARKS

Formerly 13-R3-C122

Partial documentation is available.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.
Retaining Wall Design			713-F5-C1-030
PREPARING AGENCY			
Kansas City District			
AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STATUS OF PROGRAM: STAGE
Marion M. Harter Byron E. Bircher	November 1964	Init	Rep

A. PURPOSE OF PROGRAM

This program designs cantilever and gravity walls. By structural and stability analysis, the minimum required thickness of concrete, area of tensile steel, and shear stress at any location in a T-Wall, reversed T-Wall, or U-frame wall is obtained for a structure having an adequate factor of safety against any mode of failure. By stability analysis, the minimum dimensions of a gravity wall are obtained. Ultimate strength analysis determines structural safety factors.

B. PROGRAM SPECIFICATIONS

FORTRAN IV.

C. METHODS

EM 1110-2-2502

(ACI 318-63) Building Code.

D. EQUIPMENT DETAILS

The data processing system is a Honeywell G-437 with the following on-line equipment; card reader, 4-reel magnetic tape unit, and printer.

E. INPUT-OUTPUT

Input is on cards

Output is by the printer

F. ADDITIONAL REMARKS

Originally program number 13-R3-C107.

Documentation is available.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM	PROGRAM NO.
Analysis of Continuous Beams for Highway Bridges IV	713-K5-G3-020

PREPARING AGENCY

State Highway Department of Georgia

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STATUS OF PROGRAM: STAGE
Jose M. Nieves-Olmo Rev. by: Glenn H. Sikes			

A. PURPOSE OF PROGRAM

This program performs the complete analysis of a continuous beam for a highway bridge and reports the moments, stresses, shears, reactions, deflections and shear connector spacings produced by the dead loads and the standard highway line loads (including the special military loading and the sidewalk line load) defined by the AASHTO "Standard Specifications for Highway Bridges," 1969, Interims 1970, 1971.

B. PROGRAM SPECIFICATIONS

FORTRAN IV

C. METHODS

Classical theories for the analysis of statically indeterminate structures are used. Simpson's method is used to elevated the integrals required to compute the elastic properties of the beam and influence line areas. Moment-Area Theorems and Maxwell's Law of Reciprocal Deflections are used to compute deflections and influence lines for deflections. One cycle Moment Distribution is used for the distribution of fixed-end moments.

D. EQUIPMENT DETAILS

IBM 360, Mod. 50
Card Reader, Printer

E. INPUT-OUTPUT

Input - Cards
Output - Printer

F. ADDITIONAL REMARKS

For a detailed description of the Method of Solution, see Vol 1 of the write-up, "The Analysis of Continuous Beams for Highway Bridges," written for the IBM 650 computer.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.
Biaxial Bending			713-F6-C1-02C
PREPARING AGENCY			
Kansas City District			
AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STATUS OF PROGRAM: STAGE
Byron Bircher			Op.

A. PURPOSE OF PROGRAM

This program performs an elastic analysis on rectangular reinforced concrete members such as "hammerhead" type bridge piers.

B. PROGRAM SPECIFICATIONS

FORTRAN IV

C. METHODS

This program locates the neutral axis for any given rectangular reinforced concrete member subject to biaxial bending. Then the maximum concrete stress and stress for each reinforcement bar is determined based on a straight line elastic analysis.

D. EQUIPMENT DETAILS

Honeywell G-437; card reader and printer.

E. INPUT-OUTPUT

F. ADDITIONAL REMARKS

Documentation is available.

ELECTRONIC COMPUTER PROGRAM ABSTRACT			
TITLE OF PROGRAM Stilling Basin Uplift			PROGRAM NO. 713-F5-C1-050
PREPARING AGENCY Kansas City District			
AUTHOR(S) Byron Bircher	DATE PROGRAM COMPLETED	STATUS OF PROGRAM PHASE	STAGE Op.

A. PURPOSE OF PROGRAM

This program computes uplift force and safety factor against uplift for the stilling basin structure, considering the basin to act as a monolithic unit. Quantities and controlling dimensions are also provided.

B. PROGRAM SPECIFICATIONS

FORTRAN IV

C. METHODS

D. EQUIPMENT DETAILS

Honeywell G-437/Remote batch

E. INPUT-OUTPUT

F. ADDITIONAL REMARKS

Documentation is available.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.
Intake Tower Stability			713-F5-C1-070
PREPARING AGENCY			
Kansas City District			
AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STATUS OF PROGRAM: STAGE
Morris Canaden			Op.

A. PURPOSE OF PROGRAM

Computes stability analysis including foundation pressures are provided for a typical intake tower.

B. PROGRAM SPECIFICATIONS

FORTRAN

C. METHODS

Variations to tower geometry can be easily handled through input card manipulation. Quantities are also furnished.

D. EQUIPMENT DETAILS

Honeywell G-437/Remote card

E. INPUT-OUTPUT

Input - cards
Output - Printer

F. ADDITIONAL REMARKS

Documentation is available.

Contact Byron Bircher of KCD for information.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.
Plane Frame Matrix Analysis			713-F5-C1-190
PREPARING AGENCY			
Kansas City District			
AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STATUS OF PROGRAM: STAGE
Byron Bircher			Op.

A. PURPOSE OF PROGRAM

Structural frame analysis using Matrix Methods.

B. PROGRAM SPECIFICATIONS

FORTRAN IV

C. METHODS

An extremely versatile program capable of analyzing any two-dimensional frame structure with 10 members or less, regardless of the members geometry or sectional properties.

D. EQUIPMENT DETAILS

Honeywell G-437/Remote batch

E. INPUT-OUTPUT

Input - cards
Output - Printer

F. ADDITIONAL REMARKS

Documentation is available.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.
Reinforced Concrete Pipe Design			713-F5-C1-100
PREPARING AGENCY			
Kansas City District			
AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STATUS OF PROGRAM: STAGE
Harold Fowlkes			Op.

A. PURPOSE OF PROGRAM

The program analyzes reinforced concrete pipe under various loading conditions. For wall thickness and concrete and reinforcing steel stresses for the particular pipe under investigation, the maximum height of fill allowable over the pipe and area of steel required for the inner and outer cages are computed.

B. PROGRAM SPECIFICATIONS

FORTRAN IV

C. METHODS

D. EQUIPMENT DETAILS

Honeywell G-437/Remote batch

E. INPUT-OUTPUT

Input - cards

Output - printer

F. ADDITIONAL REMARKS

Documentation is available.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.
Floodway Stability Analysis			713-F5-C1-170

PREPARING AGENCY

Kansas City District

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STATUS OF PROGRAM: STAGE
Harold Fowlkes			Op.

A. PURPOSE OF PROGRAM

The program was developed to use in the design of earth bearing, reinforced concrete inverted "T" wall.

B. PROGRAM SPECIFICATIONS

FORTRAN IV.

C. METHODS

For structural shapes and assumed loading conditions; shears, moments, reinforcing steel, maximum foundation pressure and sliding and overturning safety factors are developed.

D. EQUIPMENT DETAILS

Honeywell G-437/Remote batch

E. INPUT-OUTPUT

Input - Cards

Output - Printer

F. ADDITIONAL REMARKS

Documentation is available.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.
Stress Analysis Due to Bending & Compressive Thrust			713-F5-C1-02A
PREPARING AGENCY Kansas City District			
AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM PHASE	STAGE
Byron Bircher			Op.

A. PURPOSE OF PROGRAM

A method for analyzing a beam or column subject to any combination of moment, shear, and axial load using work stress methods.

B. PROGRAM SPECIFICATIONS

FORTRAN

C. METHODS

D. EQUIPMENT DETAILS

Honeywell G-437/Remote batch

E. INPUT-OUTPUT

Input - Card

Output - Printer

F. ADDITIONAL REMARKS

Documentation is available.

Appendix B: Abstracts of the Omaha District Structural Engineering Computer Programs

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.
Moment Distribution - Multistory Frame			713-R1-C2-050

PREPARING AGENCY

Omaha District, Corps of Engineers

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STAGE
P. E. Boldan			

A. PURPOSE OF PROGRAM

The purpose of the program is to compute moments and shears at the joints of all members.

B. PROGRAM SPECIFICATIONS

Chained program 3,480 ten-character words per chain

FORTRAN II

C. METHODS

Moment and shear distribution - program limited to orthogonal members, all columns in a particular story must be of uniform length, all base columns must be either fixed or free (not mixed).

D. EQUIPMENT DETAILS

RCA 301 processor
RCA 382 tape station
Reader
Printer

E. INPUT-OUTPUT

Input - No. of floors; no. of rows of columns; no. of load conditions span lengths; story heights; column and beam I's; and loads.

Output - Moment and shear at member ends.

F. ADDITIONAL REMARKS

Functional Area - Structural Engineering

1. Program not considered appropriate for Corps-wide use. It is too limited in the type of structure it will solve. It was written for the RCA 301 where the matrix approach was too time consuming.
2. Developed for limited use.
3. Used for preliminary design
4. Generally free of coding errors.
5. Documentation is poor.
6. Briefly tested for method.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM	PROGRAM NO.
PCA Airport Pavement Design	713-M1-C2-070

PREPARING AGENCY

Omaha District

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STAGE

A. PURPOSE OF PROGRAM

Determines flexural stresses in a concrete pavement for aircraft gear loads.

B. PROGRAM SPECIFICATIONS

FORTRAN

C. METHODS

It is based on Westergaard's Analysis for loads at the interior of a pavement slab supported by a dense liquid subbase. Loads are assumed to be uniformly distributed on ellipitical shapes representing tire contact areas.

D. EQUIPMENT DETAILS

Honeywell G-437

E. INPUT-OUTPUT

Input - CARDS

F. ADDITIONAL REMARKS

Originally from Seattle District (713-K5-G3-310).

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM PCA Prestressed Bridge Design	PROGRAM NO. 713-M1-C2-090
PREPARING AGENCY Omaha District	

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STATUS OF PROGRAM: STAGE

A. PURPOSE OF PROGRAM

Analysis and design of simple-span, precast-prestressed highway or railway bridges.

B. PROGRAM SPECIFICATIONS

FORTRAN

C. METHODS

The program will accommodate the composite and non-composite sections. The printout will include the following: section properties, dead load and live load reactions, shear and moments, stresses for various loading conditions, ultimate moments required and provided, spacing of shear reinforcements (horizontal shear stress between the composite slab and precast member), midspan elastic deflections for various loading conditions.and the number and center of gravity of prestressing strands required.

D. EQUIPMENT DETAILS

Honeywell G-437 Batch

E. INPUT-OUTPUT

F. ADDITIONAL REMARKS

Originally from Seattle District.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM	PROGRAM NO.
Steel I-Column Design for Multistory Frames	713-M1-C2-100

PREPARING AGENCY

Omaha District, Corps of Engineers

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STATUS OF PROGRAM: STAGE
W. Gaube P. Boldan			

A. PURPOSE OF PROGRAM

The purpose ov the program is to make calculations similar to those made by a column designer by hand methods except that K for sidesway permitted is calculated by the program.

B. PROGRAM SPECIFICATIONS

H-635
FORTRAN IV

C. METHODS

Conforms basically to AISC Seventh Edition

D. EQUIPMENT DETAILS

H-635 via User's Terminal

E. INPUT-OUTPUT

Input - K (If sidesway not permitted), table of columns, Column length and beam I/L, base column fixity and loads.

Output - Lightest column in the table which is adequate for the given loading plus equations utilized, k values, stresses and identifiers

F. ADDITIONAL REMARKS

Functional Area - Structural Engineering
1. Corps wide application.
2. Potentially broad application.
3. Used for final design.
4. Generally free of coding errors.
5. Documentation - Fair
6. Briefly tested.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM	PROGRAM NO.
Cantilever Sheet Pile	713-M1-C2-130

PREPARING AGENCY
Omaha District

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STATUS OF PROGRAM: STAGE

A. PURPOSE OF PROGRAM

The purpose of this program is to analyze the design of a cantilever retaining wall.

B. PROGRAM SPECIFICATIONS

C. METHODS

Given the height of sheet piling, water levels, the weights of soil and water, and the allowable stress in the steel, the program computes moments and pressures, the maximum moment, total length, and the required section modulus. The active and passive pressures are computed using Caulomb's Theory.

D. EQUIPMENT DETAILS

Honeywell G-437 Batch

E. INPUT-OUTPUT

F. ADDITIONAL REMARKS

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.
2-D Frame			713-M1-C2-200
PREPARING AGENCY			
Omaha District			
AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STATUS OF PROGRAM: STAGE
E. L. Wilson Univ. of California	Sept 1967		OP

A. PURPOSE OF PROGRAM

Determines joint deflection, member end forces, and joint reactions for plane frames which may be subjected to joint loads, joint displacements, member loads, supports may be rigid or linearly elastic.

B. PROGRAM SPECIFICATIONS

FORTRAN

C. METHODS

Members may be non-prismatic. Member to joint connections may be flexible (partially rigid).

D. EQUIPMENT DETAILS

Honeywell G-437

E. INPUT-OUTPUT

Input - Each joint and member of a structure is given an identification number starting with one. Material property, structure geometry, support data and loading are supplied by the user.

Output - Described above.

F. ADDITIONAL REMARKS

Documentation available.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM	PROGRAM NO.
2-D Frame Combined Load Cases	713-M1-C2-20A

PREPARING AGENCY

Omaha District

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STATUS OF PROGRAM: STAGE
E. L. Wilson Univ. of California			

A. PURPOSE OF PROGRAM

Determines joint deflection, member end forces, and joint reactions for plane frames. Results of runs for individual load cases can be combined in any desired ratio.

B. PROGRAM SPECIFICATIONS

FORTRAN

C. METHODS

Essentially the same as 2-D Frame (713-M1-C2-200), except the data is entered in a different order so that data sets are not interchangeable.

D. EQUIPMENT DETAILS

Honeywell G-437 Batch

E. INPUT-OUTPUT

F. ADDITIONAL REMARKS

Documentation available.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.	
Moment Distribution for Continuous Beams			713-R1-C2-210	
PREPARING AGENCY Omaha District, Corps of Engineers				
AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM		
		PHASE	STAGE	
P. E. Boldan				

A. PURPOSE OF PROGRAM

To compute moments and shears at the reactions of a continuous beam.

B. PROGRAM SPECIFICATIONS

Program size 12,600 cm cells (Octal)

FORTRAN II

C. METHODS

Program utilizes short-cut moment distribution methods by Gere and Weaver.

D. EQUIPMENT DETAILS

Program should adapt to any machine which will run FORTRAN II.

E. INPUT-OUTPUT

Input - Number of spans, moments of inertia, loads (point or evenly distributed continuous), and type of end fixity.

Output - Moments and shears at span ends.

F. ADDITIONAL REMARKS

Functional Area - Structural Engineering
1. Appropriate for Corps-wide application.
2. Worthwhile as a subroutine for larger specialized programs.
3. Used for preliminary design.
4. Generally free of coding errors.
5. Documentation is fair.
6. Thoroughly tested.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM
T-Type Flood Walls

PROGRAM NO.
713-M1-C2-370

PREPARING AGENCY
Omaha District

AUTHOR(S)
S.A. Williams - St. Louis District
Rev. By: See Section F Below

DATE PROGRAM COMPLETED
Jan 1970

STATUS OF PROGRAM
PHASE | STAGE

A. PURPOSE OF PROGRAM

This program obtains an optimum section of a T-type flood wall as required for over-turning stability and determines the base pressure, moments, and shears for use in designing the wall components.

B. PROGRAM SPECIFICATIONS

FORTRAN

C. METHODS

The method of analyzing the over-turning stability of the flood wall is based on design criteria specified in EM 1110-2-2501. Uplift forces are determined by creep theory on the assumption that the creep path begins at the bottom of the riverside face of the key. The distribution of passive resistance is assumed to be as shown on Fig (b) of the EM for one condition and according to para S-21 A(1) of the EM.

D. EQUIPMENT DETAILS

Honeywell G-437 with card reader, high speed printer, 4 magnetic tapes, 1 card punch and hardware MOVE.

E. INPUT-OUTPUT

Input - The program requires input data specifying the geometry of the structure, soil weight, and water loading conditions.

Output - Output provides the bending moment and shears necessary to design the flood wall.

F. ADDITIONAL REMARKS

Original program revised in St. Paul District by M. B. Downs and G. Cohen.
St. Paul program no. 713-G1-F5-060.
Documentation available from St. Paul District.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.
Multicell Box Culvert			713-M1-C2-380
PREPARING AGENCY: Omaha District			
AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STAGE

A. PURPOSE OF PROGRAM

Designed to analyze frames having variable cross sections.

B. PROGRAM SPECIFICATIONS

FORTRAN

C. METHODS

The cross sections are rectangular with haunches. The program will handle a wide variety of configurations because each joint is treated separately and independently. It uses the Hardy cross method of moment distribution.

D. EQUIPMENT DETAILS

Honeywell G-437

E. INPUT-OUTPUT

Input- Member dimensions and loads.

F. ADDITIONAL REMARKS

Obtained from the St. Louis District. Their reference number 713-R3-I3-190.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM	PROGRAM NO.
Box Culvert Moments and Shears	713-M1-C2-38A

PREPARING AGENCY
Omaha District

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STATUS OF PROGRAM: STAGE
John Harberg			

A. PURPOSE OF PROGRAM

Computes reinforcing steel requirements for multicell box culvert as analyzed by program number 713-M1-C2-380.

B. PROGRAM SPECIFICATIONS

FORTRAN

C. METHODS

D. EQUIPMENT DETAILS

Honeywell G-437 Batch.

E. INPUT-OUTPUT

F. ADDITIONAL REMARKS

Contact John Harberg of Omaha District for further information.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.
Voussior Conduit Design			713-M1-C2-390
PREPARING AGENCY			
Omaha District			
AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STATUS OF PROGRAM: STAGE
Brockman			

A. PURPOSE OF PROGRAM

A conduit analysis program in 3 segments with the primary references being: 1. PCA analysis of arches, rigid frames and sewer sections. 2. EM 1110-2-2901 conduit, culvert and pipe.

B. PROGRAM SPECIFICATIONS

FORTRAN BATCH

C. METHODS

Program segments: 1. A geometry phase which provides the coordinate description of the elements (voussiors) for which the analysis is made. The program has the capability of some variation in geometrical shape and number of voussiors to be analyzed. 2. The arch analysis based on the examples set forth in reference number one. The segment of the program provides the moment, thruse and shear at the center point of each voussoir. 3. The stress analysis phase which is based on the design criteria set forth in reference two.

D. EQUIPMENT DETAILS

Honeywell G-437

E. INPUT-OUTPUT

F. ADDITIONAL REMARKS

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.
Vanderbilt Frame			713-M1-C2-400

PREPARING AGENCY
Omaha District

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STAGE
Vanderbilt University			

A. PURPOSE OF PROGRAM

Used to solve for shear, moment, deflection, and rotation at the joints of plane frames or continuous beams of 34 members or less.

B. PROGRAM SPECIFICATIONS

FORTRAN

C. METHODS

Each member must have a constant modulus of elasticity and moment of inertia throughout its length. Moments of inertia may be real or relative. Members must be orthogonal and continuous at the joints, axial shortening is not considered. Used the stiffness method of analysis where the unknown quantities are translations and rotations.

D. EQUIPMENT DETAILS

Honeywell G-437

E. INPUT-OUTPUT

Input - Structure data, number of members, member of kinematic redundants or degrees of freedom, number of reactions, modulus of elasticity, member data, member number, rotations at ends, vertical displacements, length of member, moment of inertia, fixed end moments, and fixed end reaction. Joint loads, moment, and vertical and horizontal force.

F. ADDITIONAL REMARKS

Documentation available.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM Stability of Rigid Structures	PROGRAM NO. 713-M1-C2-410
PREPARING AGENCY Omaha District	

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STATUS OF PROGRAM: STAGE
Tim Knight			

A. PURPOSE OF PROGRAM

Analysis of a structure for sliding and overturning.

B. PROGRAM SPECIFICATIONS

FORTRAN

C. METHODS

D. EQUIPMENT DETAILS

Honeywell G-437 CARD

E. INPUT-OUTPUT

F. ADDITIONAL REMARKS

Call Tim Knight of Omaha District for details.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM Finite Element Method in Structural Analysis	PROGRAM NO. 713-M1-C2-420

PREPARING AGENCY

Omaha District

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STATUS OF PROGRAM: STAGE
University of Missouri at Rolla			

A. PURPOSE OF PROGRAM

The program determines deformation and stresses within 2-D plane stress structures or arbitrary shapes. The effects of displacement boundary conditions, uniform loads, concentrated loads, and gravity forces are included.

B. PROGRAM SPECIFICATIONS

FORTRAN

C. METHODS

The program is written for planes of stress or strain, triangular elements, but by studying "The Chapter 15 Finite Element Method in Structural and Continium Mechanics" by D. C. Ziennkiewica and Y. K. Cheung, it can be changed by the substitution of appropriate subroutines in order to study plates and shells, 3-dimensional solids.

D. EQUIPMENT DETAILS

Honeywell G-437 CARD

E. INPUT-OUTPUT

F. ADDITIONAL REMARKS

Documentation available

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.
Axisymmetric Solids			713-M1-C2-430
PREPARING AGENCY			
Omaha District			
AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STATUS OF PROGRAM: STAGE
E. L. Wilson University of California	Feb 1967		

A. PURPOSE OF PROGRAM

Determines deformations and stresses within axisymmetric structures of arbitrary shape.

B. PROGRAM SPECIFICATIONS

C. METHODS

The effects of displacement or stress boundary conditions, concentrated loads, gravity forces, and temperature changes are included. Non-linear material properties are included by a succesive approximation technique. An axisymmetric solid is one that can be generated by the rotation of a cross-section about a line.

D. EQUIPMENT DETAILS

Honeywell G-437 Batch

E. INPUT-OUTPUT

F. ADDITIONAL REMARKS

Documentation available.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM	PROGRAM NO.
I-Wall Analysis, Four Soil Zones	713-M1-C2-500

PREPARING AGENCY

Omaha District

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM — PHASE	STATUS OF PROGRAM — STAGE

A. PURPOSE OF PROGRAM

It determines the loads on a "I" wall embedded in a maximum of four soil zones and subjected to a full flood in order that a section can be designed to insure structural stability.

B. PROGRAM SPECIFICATIONS

FORTRAN

C. METHODS

The method of solution follows EM 1110-2-2906 satisfying the static laws of equilibrium and is developed to obtain by trial the depth of penetration.

D. EQUIPMENT DETAILS

Honeywell G-437 Card

E. INPUT-OUTPUT

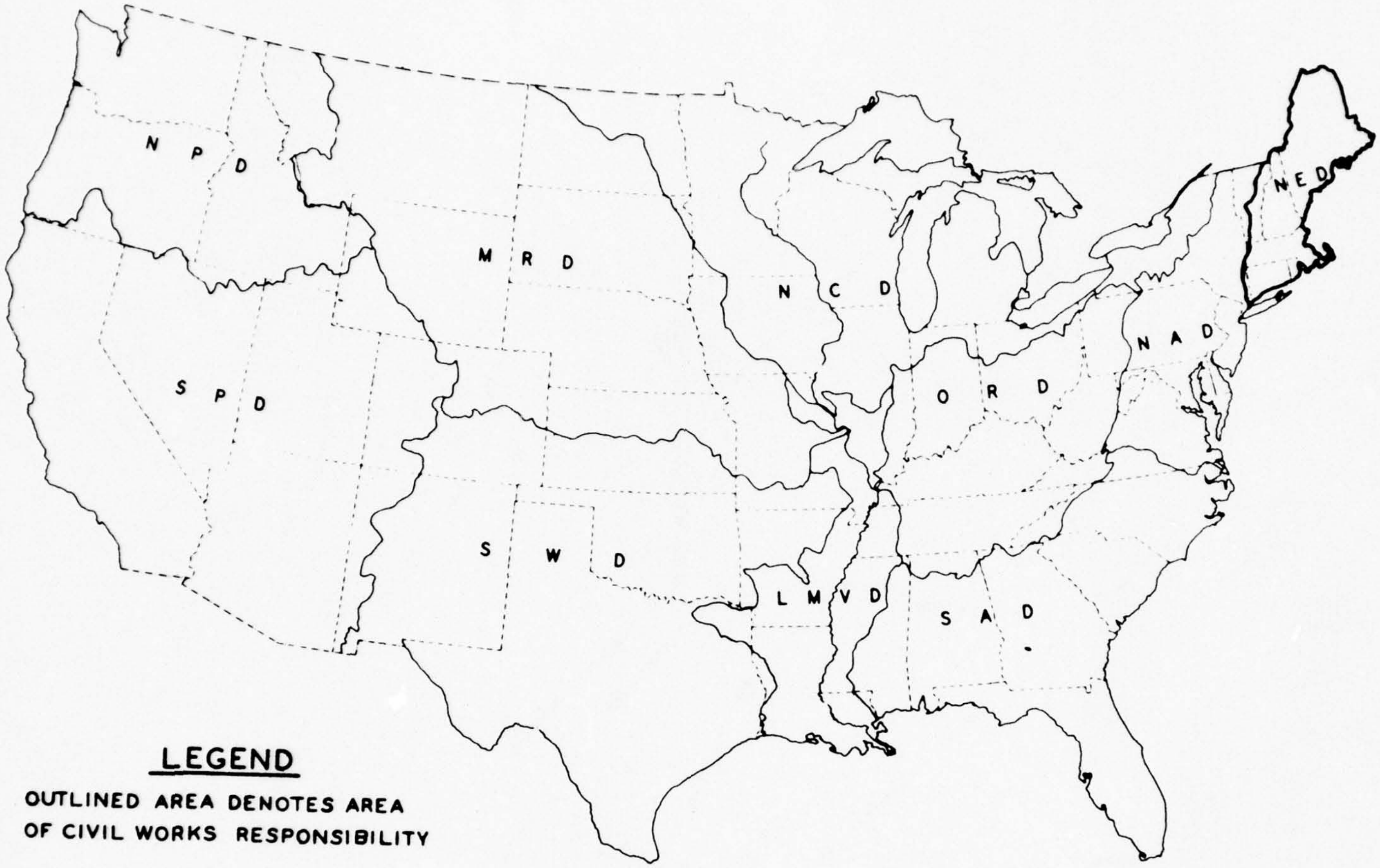
Input - Data required are the ground line slopes, height of wall, and the effective unit weight, angle of internal friction and cohesion and thickness of each soil zone, for up to 4 soil zones.

Output - Net load, shear and bending moment diagrams, and the depth of penetration.

F. ADDITIONAL REMARKS

Obtained from the St. Louis District (713-G1-A3-02).

NEW ENGLAND DIVISION



LEGEND

OUTLINED AREA DENOTES AREA
OF CIVIL WORKS RESPONSIBILITY

NEW ENGLAND DIVISION

by

William J. Holtham*

Introduction

The New England Division (NED) is one of 10 Civil Works Divisions in the United States and reports directly to the Office, Chief of Engineers (OCE), Washington, D. C. The Division Office is located in Waltham, Mass., 12 miles west of Boston. The Division Civil Works program encompasses five river basins and the coastal region. It is responsible for design and construction for flood control, water supply, hurricane barriers, navigation channels, hydroelectric power, local flood protection projects, and beach erosion, in addition to operation and maintenance of the Cape Cod Canal.

NED has a staff of 700 civilians, including 200 professional engineers. We operate and maintain 55,000 acres of land and water; this includes 36 reservoirs, 38 local protection projects, and four hurricane barriers, in addition to dredging and harbor facilities in the 6,000-mile coastal region. The construction projects have cost $300 million and have prevented $200 million in damages to date. The Division work load varies from $30 to $60 million annually. Our recreation facilities draw more than three million visitors annually. The Division is directed by COL John H. Mason, Division Engineer.

Hardware Development

The development and use of modern computer-aided structural analysis at NED had its start in 1964 with the aid of a Mathatron programmable calculator, with a memory capacity of 480 words.

In this system the main-line program was punched on paper tape and simultaneously executed as it was read in from attached teletype. The memory was allocated to storage registers, conditional transfers, and program looping.

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* Structural Engineer, New England Division.

Although we were able to reduce our design time by 20%, this system was very slow by today's standards because of the need to read in the paper tape program every time the program was run. Not until 1970 were significant inroads in structural design finally being envisioned with the advent of the GE 200 and 400 series batch computers and the Mathatron III. The Mathatron III was an enhanced version of our original programmable calculator having an effective memory capacity of approximately 2000 words. With it we could now store entire programs in memory without any restrictions. The Mathatron III is a multiplex system that accommodates six desk terminals and a teletype simultaneously. Its dual function, as a calculator and a minicomputer, is used by our 10-man Structural Section. The GE computers were used for programs requiring a large amount of core memory. However, the use of this tool consumed many man-hours in punching up data cards and manual checking, to say nothing of the turnaround time inherent in this operational mode. It was deemed more economically feasible to run on the Mathatron III whenever program size permitted it.

With the GE system capability we were able to perform higher order analysis, such as modern finite element techniques or two-way stress analysis of our gravity dams. These analyses were impossible to perform on our smaller computers. The resulting analysis time, as compared with manual methods, was reduced in many instances from one week to one hour. It was found, however, that when our work load increased, we could not tolerate the layover time between the submission of a batch job and the obtaining of results. This inconvenience is a by-product of a batch processing system employed by many users. Therefore, in 1973 we acquired a time-sharing contract with Computer Science Corporation (CSC) using an ASR-33 Teletype with acoustic pickup. Because of the fast response and ease of data manipulation built into their system, we found ourselves working in a real time environment that was very economical and also resulted in an efficient and exacting design.

We had, from 1970 to 1972, also been exposed to the rapidly increasing use of computer graphic techniques to assist the design engineer in preparing and formulating his initial input data as well as

enhancing his ability to observe relevant structural behavorial characteristics. These two areas in particular had made it difficult to quickly develop an efficient design. After considering the benefits of computer graphics it was decided that it would be to our advantage to get involved in graphical analytical techniques. We therefore acquired in 1972 a Computek 400/20 CRT storage tube terminal and graphic tablet.

Between 1972 and 1974 we interfaced the CRT with our Mathatron III and used the program-generated graphics as an integral part of many design memos. During this time we realized the extensive time savings gained by not having to manually draw plots and graphs that were needed in our reports and memos. However, because of the relatively small size of the Mathatron III we were never able to expand our use of graphical techniques. We then decided to investigate the field of time-sharing computer graphics with large-scale structural capabilities. McDonnell Douglas Automation Company (MCAUTO) has such a system. In 1974 we obtained a contract with them to provide us with the structural graphics techniques we feel we need to keep current with the advancing state of structural analysis and design. Our existing Computer Graphic Terminal was used to access the MCAUTO facility.

All the above-mentioned hardware is located in the Structural Section; use of the ADP Center is primarily for high-speed printouts of the COPE terminal.

Program Capability

At the present time we have about 50 single-purpose programs in use on our programmable calculator system. Generally speaking, the areas covered by these programs include the following: I-walls, T-walls, gravity dam and ogee weir stability, box conduits, pressure conduits, reinforced concrete beam and steel column design, symmetrical and unsymmetrical channels subject to uplift, crane beams, tunnel supports for circular tunnels, cofferdam design, elastic center of pile groups, cross-bed shear, and embankment quantities.

When time allows we intend to convert them into multipurpose programs written in a more convenient language such as FORTRAN. Since the GE system is now dedicated to COEMIS and other related managerial functions, it is no longer available for our use. But, as was mentioned earlier, we have chosen to use the time-sharing system available through CSC and have therefore relocated out major proprietary programs with them. These programs include an in-house-developed multipurpose dam package called DAMPAC. This package includes four separate programs.

The first two are 2-dimensional stability analyses of nonoverflow and overflow gravity dams. The programs investigate sliding and overturning stability of a dam of any cross section, including one with a gallery. As options, the program will increase the upstream slope or the depth of key in order to meet existing criteria. Base pressures are also determined. Water and earth can be located at any elevation on both the upstream and downstream sides. The structure may be on either a soil or rock foundation with or without passive pressure. Uplift reduction can be made.

The third program is a stress analysis of a nonoverflow gravity dam. This program computes principal stresses at any specified elevation. Vertical and inclined compressive stress and shear stress are given as output.

The fourth and last program in DAMPAC is a 3-dimensional stability analysis of a nonoverflow gravity dam. Sliding and overturning stability of a complete monolith with either a horizontal or irregular shaped base may be investigated. The unsymmetrical projected base area is analyzed for sliding parallel and perpendicular to the baseline. Overturning is about the two perpendicular centroidal axes. Base pressures are also found.

Besides DAMPAC we have also developed a production-oriented program for matrix analysis of frame structures. This program, called EFFRAM, is basically a revised version of the "Plane Frame Analysis by Direct Stiffness" computer program acquired from Rock Island District. To this basic program we added the capability of applying multiple forms and types of loads but, most importantly, the capability of designing

any frame structure, accounting for environmental condition due to varying vertical and horizontal subgrade reactions. We accomplished this by applying the theory of elastic foundations, presented by Eduard Winkler in 1867, to our structural design. Used with the proper perspective, realizing the limits and assumptions of the elastic foundation theory, we have provided our design with a viable, while not restrictive, approach to investigating man-made structures in a natural environment. This, we feel, is imperative to a universal program for Corps-wide use. A structure should be properly analyzed whether it is built on the San Andreas Fault, the shale of Mississippi, or the granite of New England. If a program doesn't provide the capability of specifying a yielding foundation of varying subgrade moduli, it is not demonstrative of the technological advancement we have achieved to date.

EFFRAM is adapted to modulating the condition of the springs so that:

a. Springs take compression only and iterations are provided to eliminate tension and redistribute bearing pressure; nonbearing areas are defined.

b. Springs take compression and tension.

c. Springs act at nodal points only.

d. Springs act distributed between nodes; tension or nonbearing areas are defined.

e. No element need be on springs; but rather, the option is provided.

f. Variable spring constant may be specified.

Professor John T. Christian of MIT developed the basic program with the Structural Section providing the variable modes of operations.

Our other major program area in use at the present time is associated with computer graphic technology. As mentioned previously, we are using the graphical software capabilities contracted to us by MCAUTO. We are accessing this tool through our own CRT storage tube terminal. We have implemented, for example, a 3-dimensional stress and graphical analysis in the design of the massive hydraulic junction box which is part of the Hartford, Connecticut, Local Protection Project. The reinforced concrete junction box has an irregular shape; it connects

three double-barrel conduits that intersect at oblique angles. This complex structure is 140 ft in length. The average clear height is 26 ft, its width varies from 75 to 125 ft, and it has three interior beams, 6 ft deep, running longitudinally, each supported by a 4- by 10-ft pier at midspan. The analysis was performed using the computer program ICES-STRUDL II through the facilities of the MCAUTO in St. Louis, Mo. In addition, all input and output were generated using FASTDRAW, a McDonnell Douglas proprietary interactive graphics system. FASTDRAW interfaces with the STRUDL program and is accessed with the Model 400 Computex CRT storage tube terminal used for visual display.

As elaborate as the junction box was, the programs provided a thorough design. Comparable results from manual methods would have cost much more time and money. With the STRUDL program, which uses finite element techniques, the structure was fully analyzed. Two- and three-dimensional sketches were then drawn on the CRT showing shapes and deformations of the entire structure for each loading condition (see Appendix A). From these sketches the engineers readily determined the critical characteristics, e.g. stress and deflection patterns, and could observe any unanticipated anomaly. An additional benefit was the ability to analyze, view, and depict areas of concern in the junction box at all stages of construction. Understanding of the structure's behavior was further enhanced by the capability to view the structure from any angle desired. These features eliminated the extensive time required by the engineer to absorb voluminous numerical information. The use of these procedures yielded superlative results.

Computer Program Development

Funds must be provided on a Corps-wide basis and allocated by Divisions, as is R&D funding. A reasonable guideline, 10% of a design sections annual cost, would be funded by an R&D account. Program development costs are now derived from project funding. With the present system, job experiences result in truncated programs. There is an analogy here between the strength of management function versus the

design function. Corps management provides funds for its program development through overhead charges on the engineer; however, engineers must charge their program development to the job. This is demonstrative of the imbalance of control between two necessary functions. Corps managers, through COEMIS, have full control of engineers in terms of time, money, and quantity of work without a regulated management policy to assess quality; apparently this function is still the domain of the engineer. Engineers must be given the power to maintain the state of the art not only as individuals but as a group, collectively. The state-of-the-art function today encompasses electronic equipment that is changing techniques and producing a higher level of enlightenment in engineering design activities. Changes to the techniques are rapid as the achievement level progresses. What was impossible to do manually a year ago is possible today with the computer; what is impossible today may be possible tomorrow. The WES Library is primarily composed of analysis and structural design programs that do not consider the environment nor the third dimension. To incorporate this function will be costly; a simple solution would be to adopt a general purpose program which includes CRT graphics to simulate all structures. NED has successfully used MCAUTO for this purpose.

Another management policy that may be retrogressive is Value Engineering, romanizing projects for economic benefit. Value Engineering has a beneficial role, but when carried to extremes, results in unnecessarily stark buildings prone to degradation. Thus, engineers need sophisticated tools to determine the effect of time and environment on structures. With a combination of variable parameters it may be possible to dial up the requirements of a 50-yr life or a 500-yr life structure with associated material, design, and project costs.

Because of present limitations in supporting all functional users, WES should consider making all the library available on some other system, such as CSC INFONET, so everyone can access them. At present we must borrow ports to use WES.

We would like to see a consolidated list of the computer systems and computer equipment all the various Corps Offices are using so we

can contact them when in need of information concerning the operation or peculiarities of a certain system or piece of equipment.

OCE should justify proposed requirements where many Districts and Divisions show interest. Individual justification, in this situation, is a lengthy and unnecessary procedure.

If you wish to get into the field of graphics, the simplest and cheapest way to learn about hardware and procedures is to contact the representative of a computer service company that provides graphical capabilities and ask for a demonstration. This service is "free of charge" and doesn't take long. If you still have questions about your own design needs and wonder if graphics can improve your productivity, you should call another Corps Office presently using graphical techniques and discuss your needs with them. I'm sure they can aid you in deciding whether to use graphics and, if you choose to, what system may best suit your needs. The only effort required on your part is to pick up a phone and dial.

Development must consider the future; it must contemplate today's problems, overcome them, and attack the unknown. Structural design is a combination of science and art; more technical progress reduces the art function. Higher level tools for higher order analysis provide a means for progress.

Appendix A: Index and Summary

Park River Local Protection Project

Junction Box

Summary of loading conditions and graphical output for base slab design.

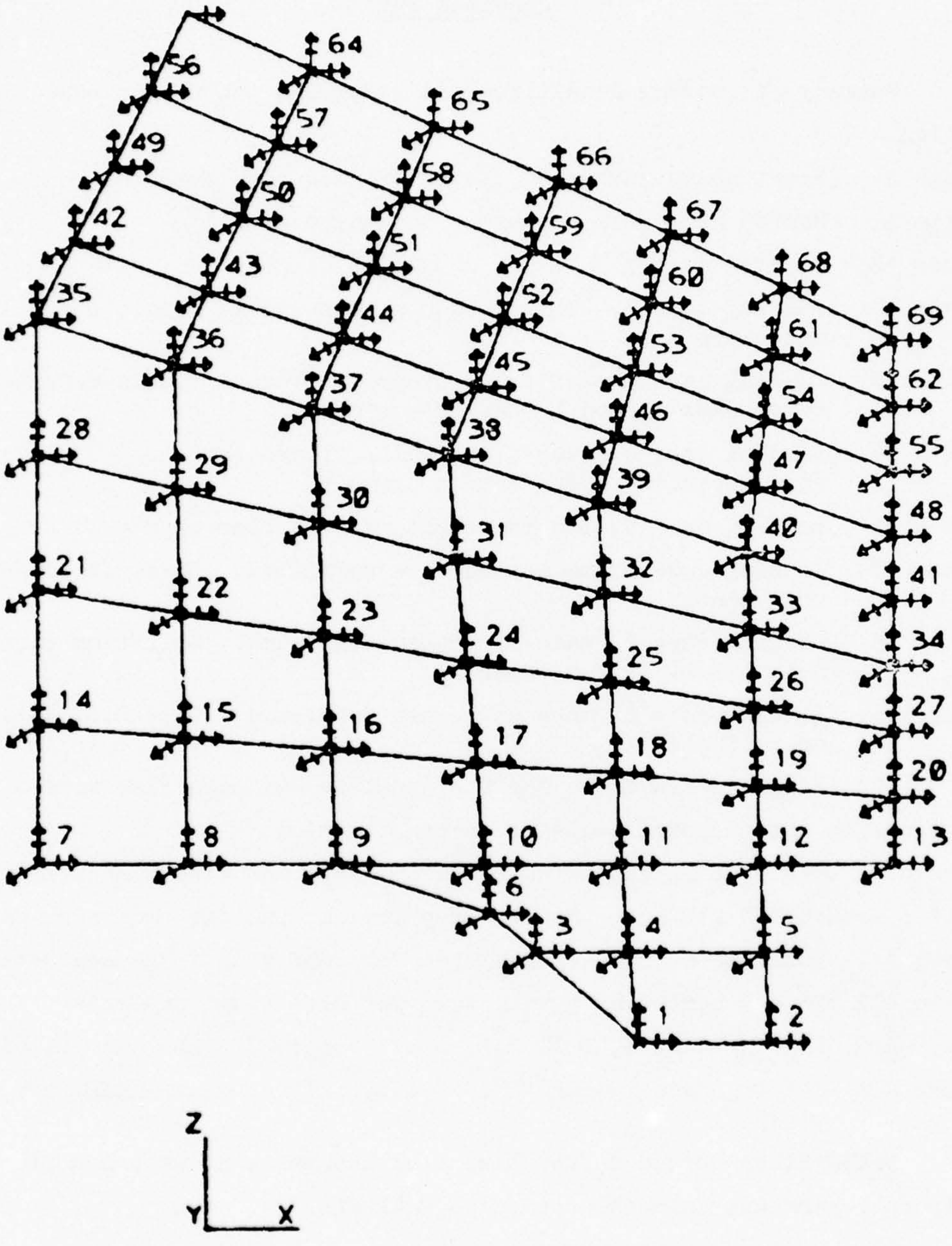
Plate A1	Nodal point numbering system of base slab grid
Plate A2	Member numbering system of base slab grid
Plate A3	Loading case 1, D.L. of base slab alone
Plate A4	Loading case 2, D.L. of base slab & liquid weight of walls and piers
Plate A5	Loading case 3, walls and piers in place & liquid weight of roof beams shored to the base slab
Plate A6	Loading case 4, base slab, walls, piers, and roof beams in place--partial frame action begun
Plate A7	Loading case 5, liquid weight of roof slab shored to beams
Plate A8	Loading case 6, main structure completed. Earth fill added to roof slab
Plate A9	Loading case 7, main structure completed. Uplift on base slab, D.L. & L.L. on roof slab
Plate A10	Loading case 8, main structure completed. Only D.L. & L.L. on roof slab

The loading cases above for the junction box base slab were set up to simulate the proposed sequence of construction.

The base slab is supported by elastic springs with a modified foundation modulus of 170 kcf. Sample graphical output for roof slab design.

Plate A11	Nodal point numbering system for roof slab frame analysis
Plate A12	Member numbering system for roof slab frame analysis
Plate A13	Loading case 1, full D.L. & L.L. on roof slab--lateral view
Plate A14	Loading case 1, full D.L. & L.L. on roof slab--longitudinal view

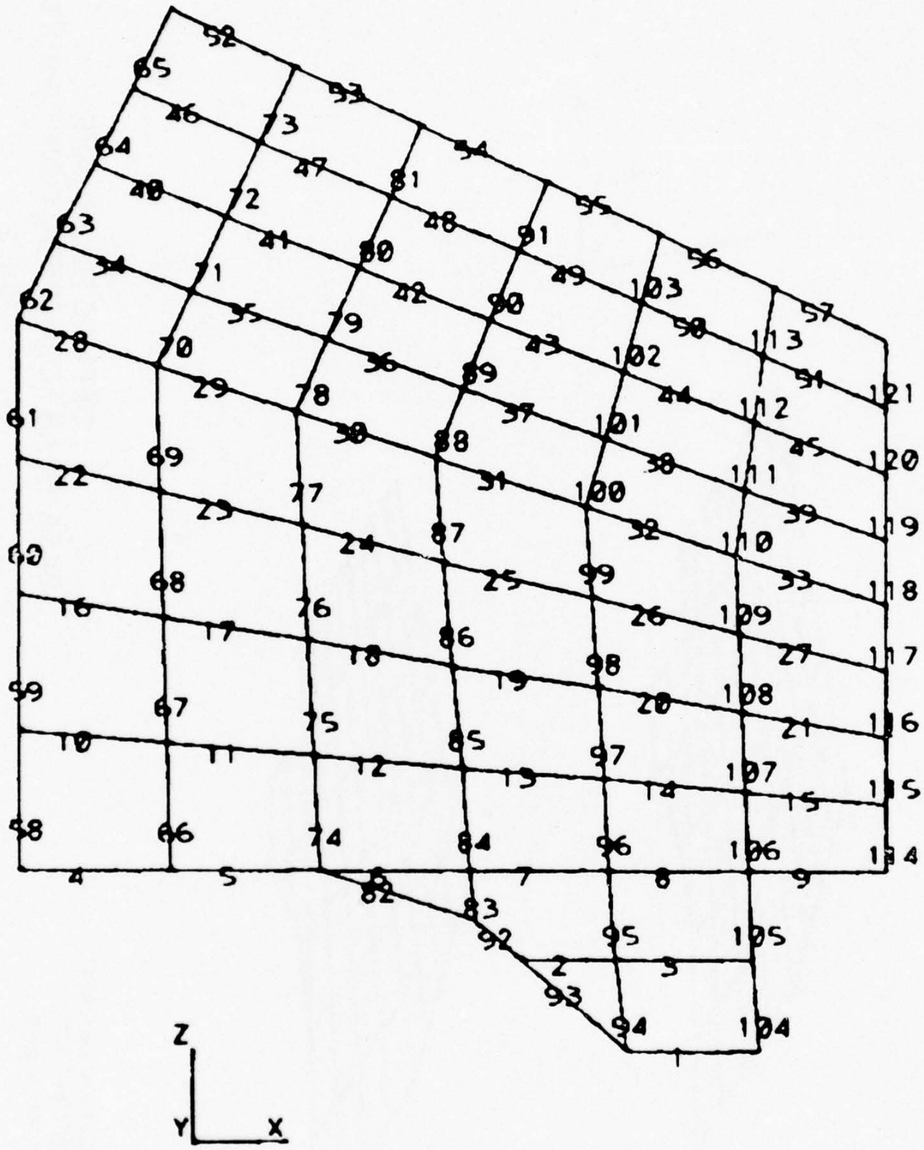
Deflections obtained from base slab analysis, at wall and pier supports, were put into the roof slab analysis.



NODAL POINT NUMBERING SYSTEM

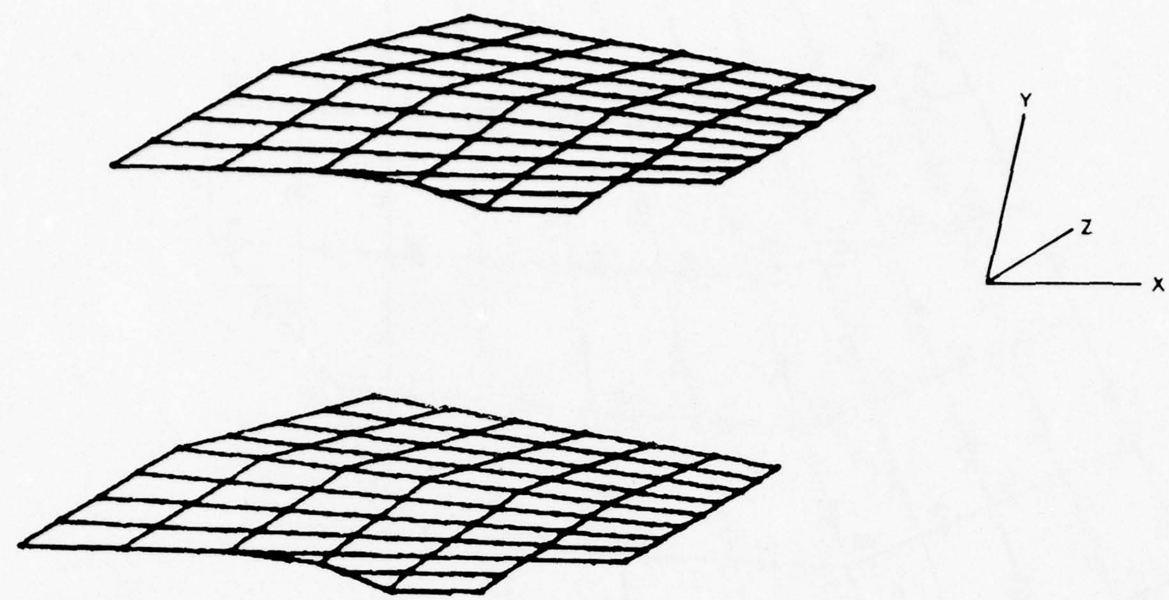
θX=-90, θY=0, θZ=0

PLATE A1



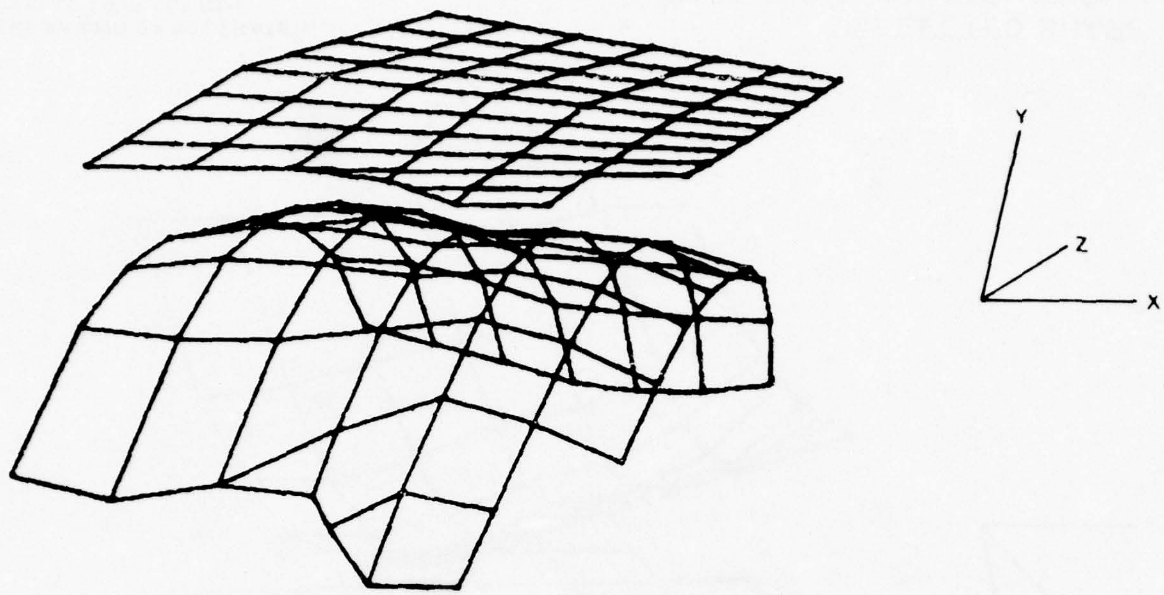
MEMBER NUMBERING SYSTEM

θX=-90, θY=0, θZ=0



NOTE: OVERLAY AND EXAGGERATED VERTICAL DEFLECTION
5-FT BASE SLAB ALONE

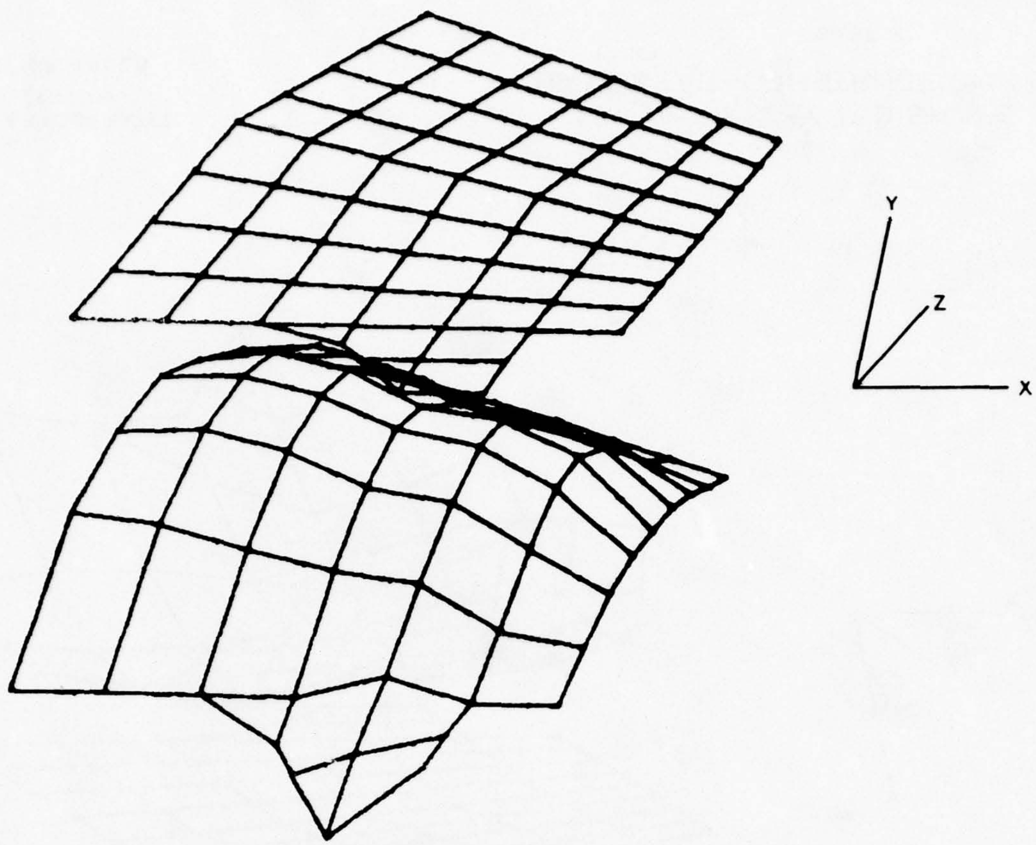
DEFLECTED SHAPE
BASE SLAB-CONSTRUCTION CONDITION
CASE 1



NOTE: OVERLAY AND EXAGGERATED VERTICAL DEFLECTION
LIQUID WEIGHT OF WALLS AND PIERS

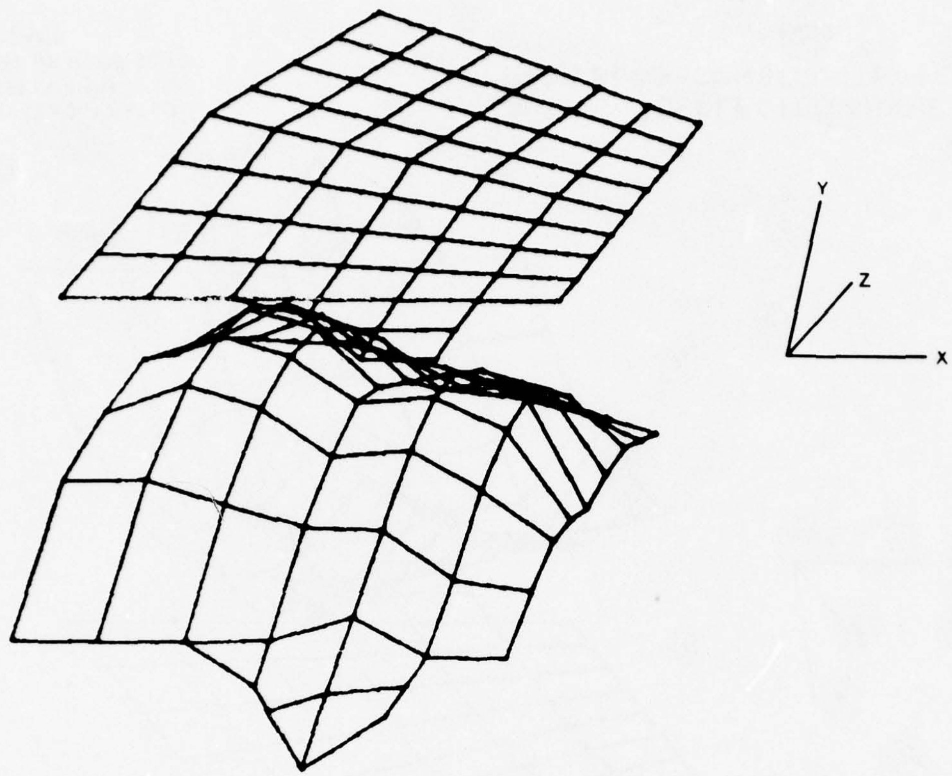
DEFLECTED SHAPE
BASE SLAB-CONSTRUCTION CONDITION

CASE 2



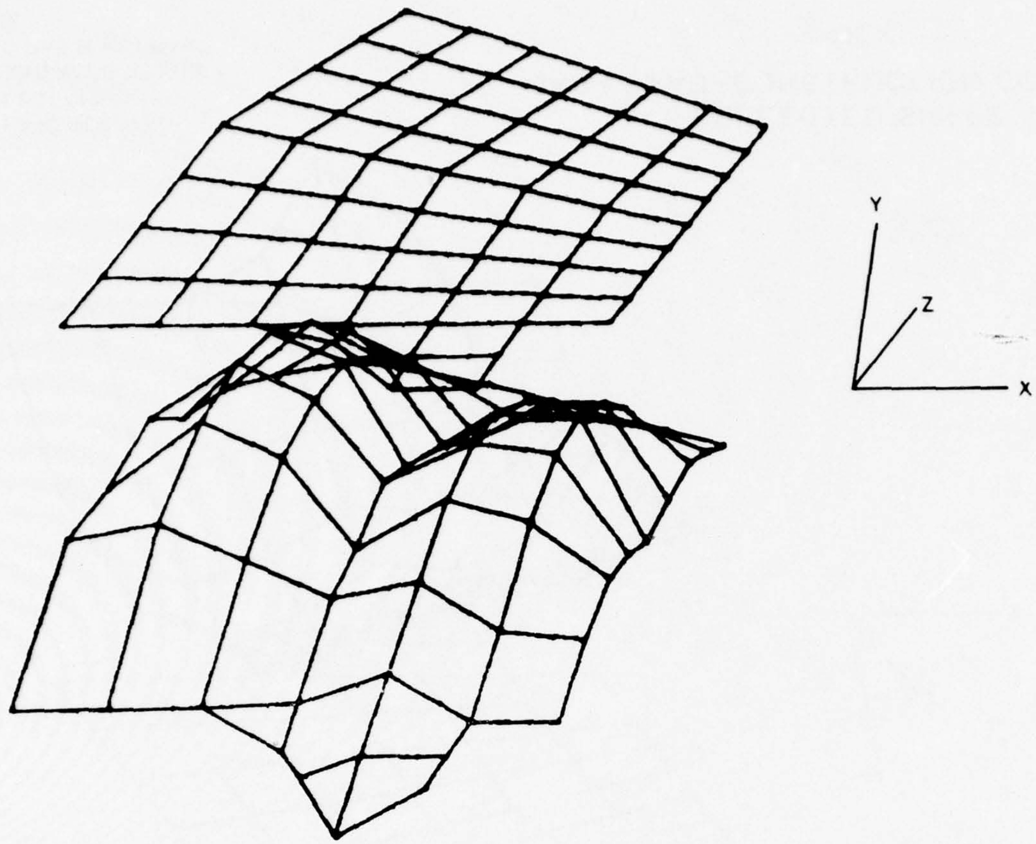
NOTE: OVERLAY AND EXAGGERATED VERTICAL DEFLECTION
WALLS AND PIERS IN PLACE
LIQUID WEIGHT OF ROOF BEAMS SHORED TO BASE SLAB

DEFLECTED SHAPE
BASE SLAB-CONSTRUCTION CONDITION
CASE 3



NOTE: OVERLAY AND EXAGGERATED VERTICAL DEFLECTION
WALLS, PIERS, AND ROOF BEAMS IN PLACE; AND PARTIAL FRAME ACTION BEGUN

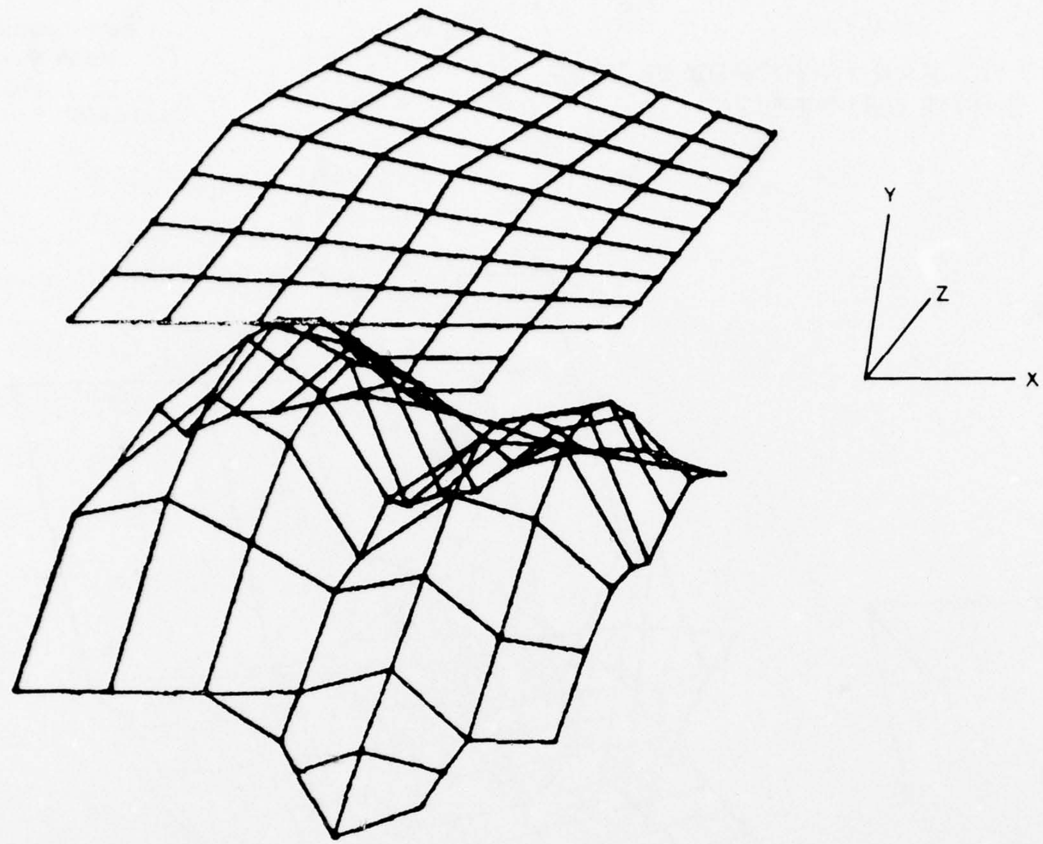
DEFLECTED SHAPE
BASE SLAB-CONSTRUCTION CONDITION
CASE 4



NOTE: OVERLAY AND EXAGGERATED VERTICAL DEFLECTION
LIQUID WEIGHT OF ROOF SLAB SHORED TO BEAMS

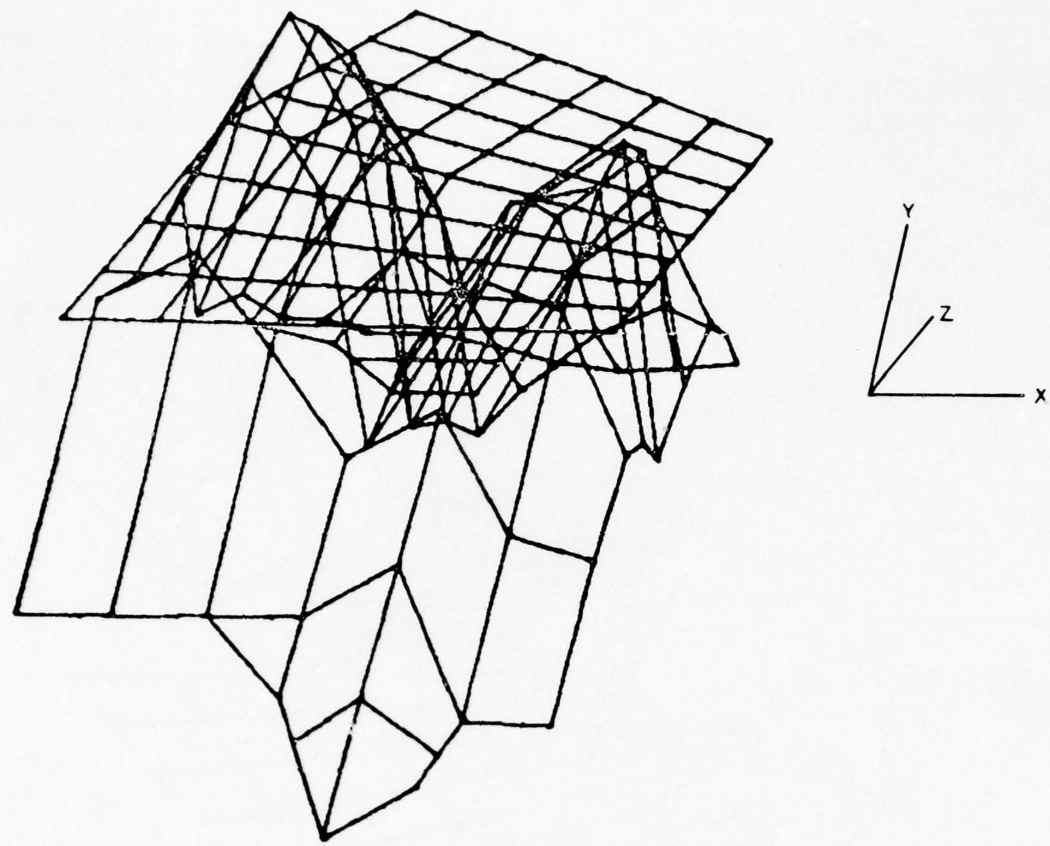
DEFLECTED SHAPE
BASE SLAB-CONSTRUCTION CONDITION

CASE 5



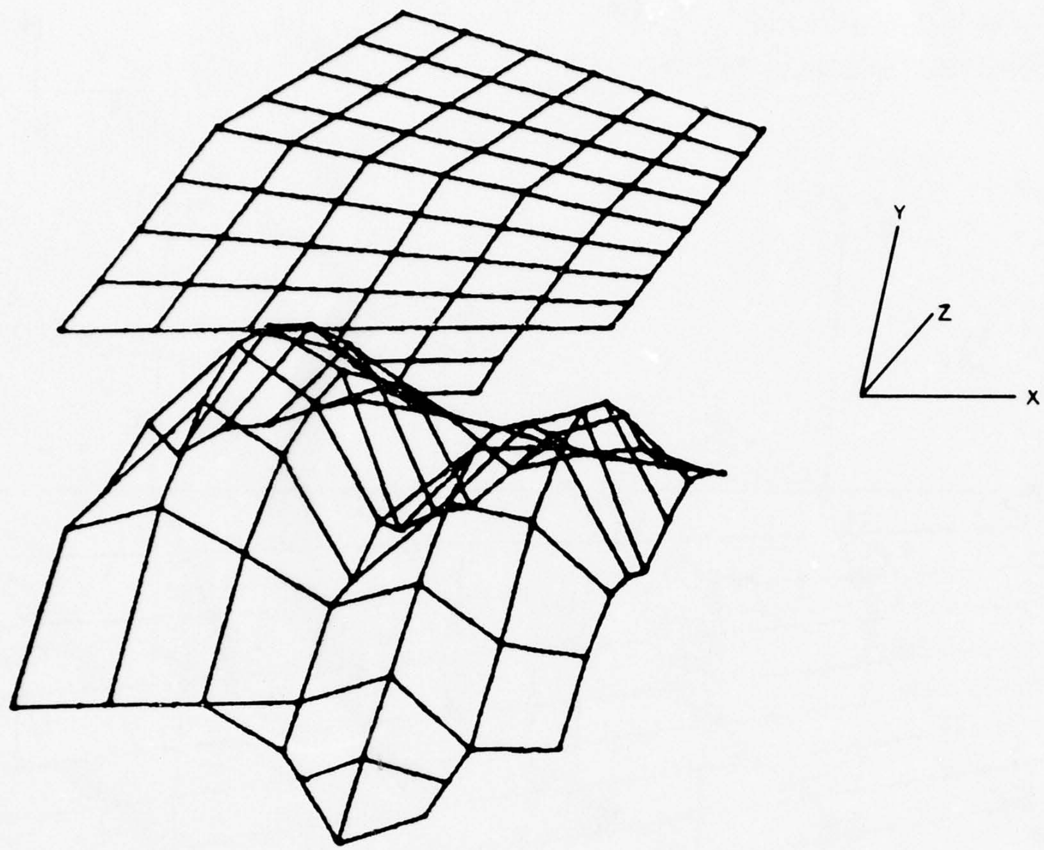
NOTE: OVERLAY AND EXAGGERATED VERTICAL DEFLECTION
MAIN STRUCTURE COMPLETED
EARTH FILL ADDED TO ROOF SLAB

DEFLECTED SHAPE
BASE SLAB-CONSTRUCTION CONDITION
CASE 6



NOTE: OVERLAY AND EXAGGERATED VERTICAL DEFLECTION
UPLIFT ON BASE SLAB
D.L.+L.L. ON ROOF SLAB

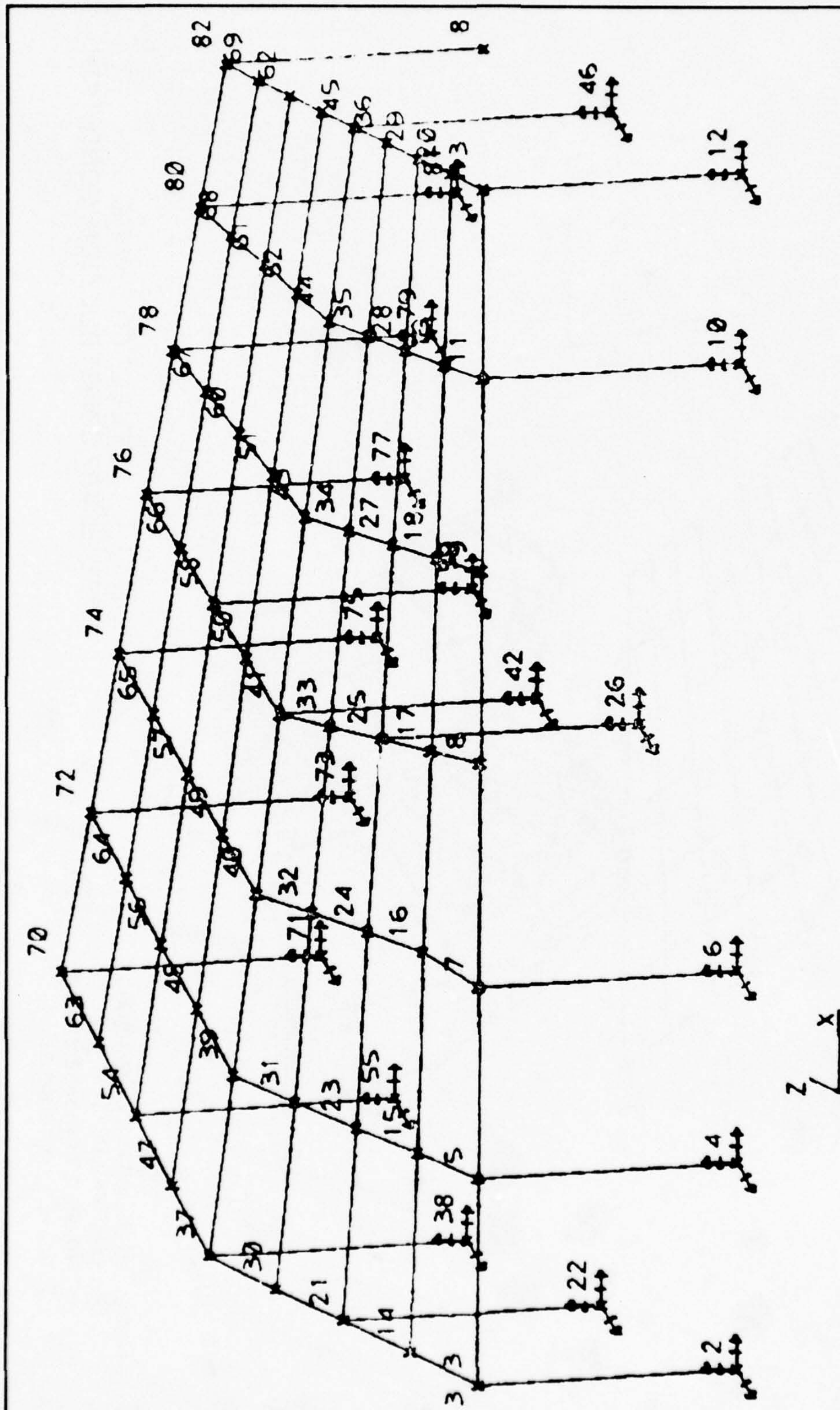
DEFLECTED SHAPE
BASE SLAB-CONSTRUCTION CONDITION
CASE 7



NOTE: OVERLAY AND EXAGGERATED
VERTICAL DEFLECTION
NO UPLIFT ON BASE SLAB
D.L. +L.L. ON ROOF SLAB

DEFLECTED SHAPE
BASE SLAB–CONSTRUCTION CONDITION

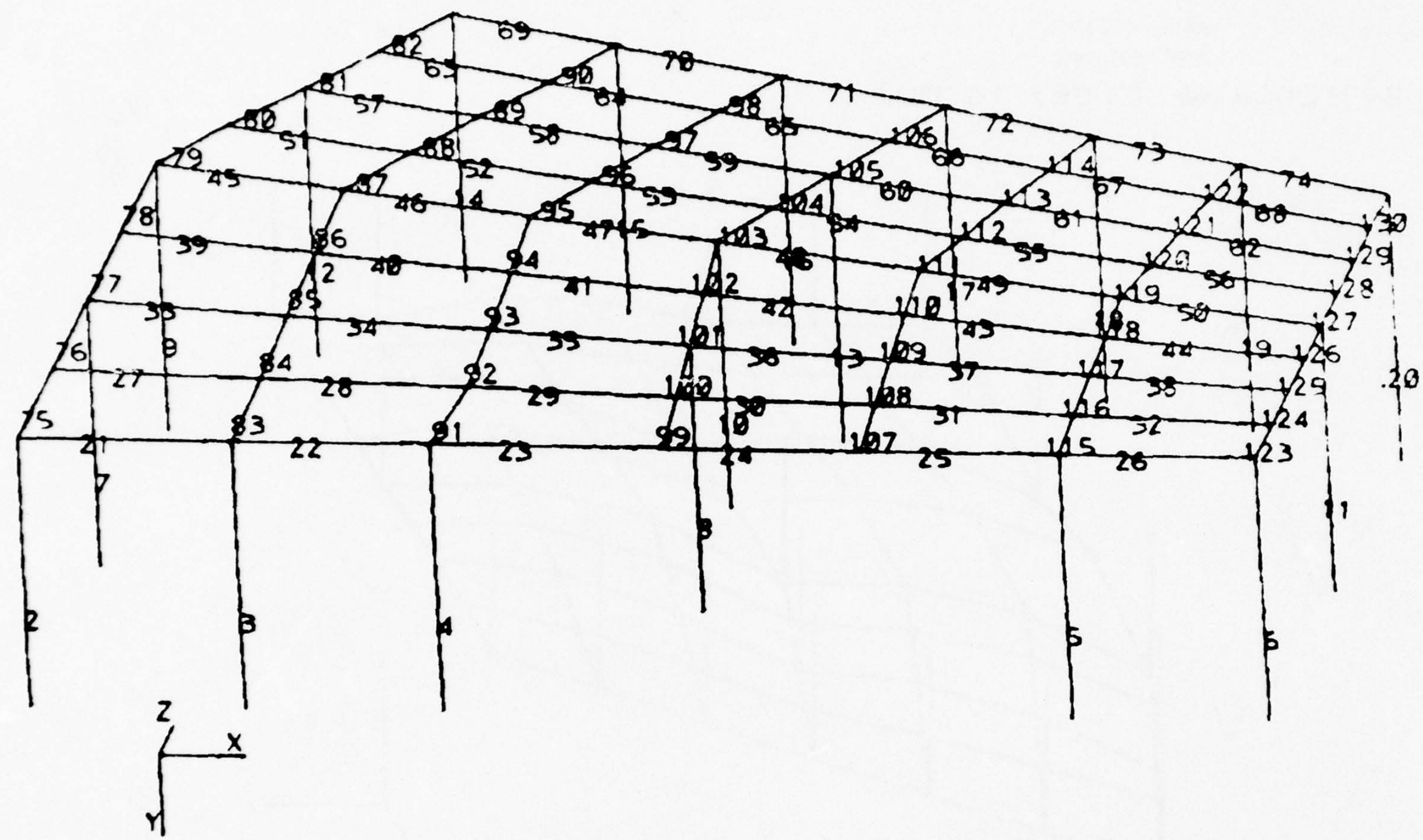
CASE 8



NODAL POINT NUMBERING SYSTEM

θX=20, θY=-170, θZ=-180

PLATE A11



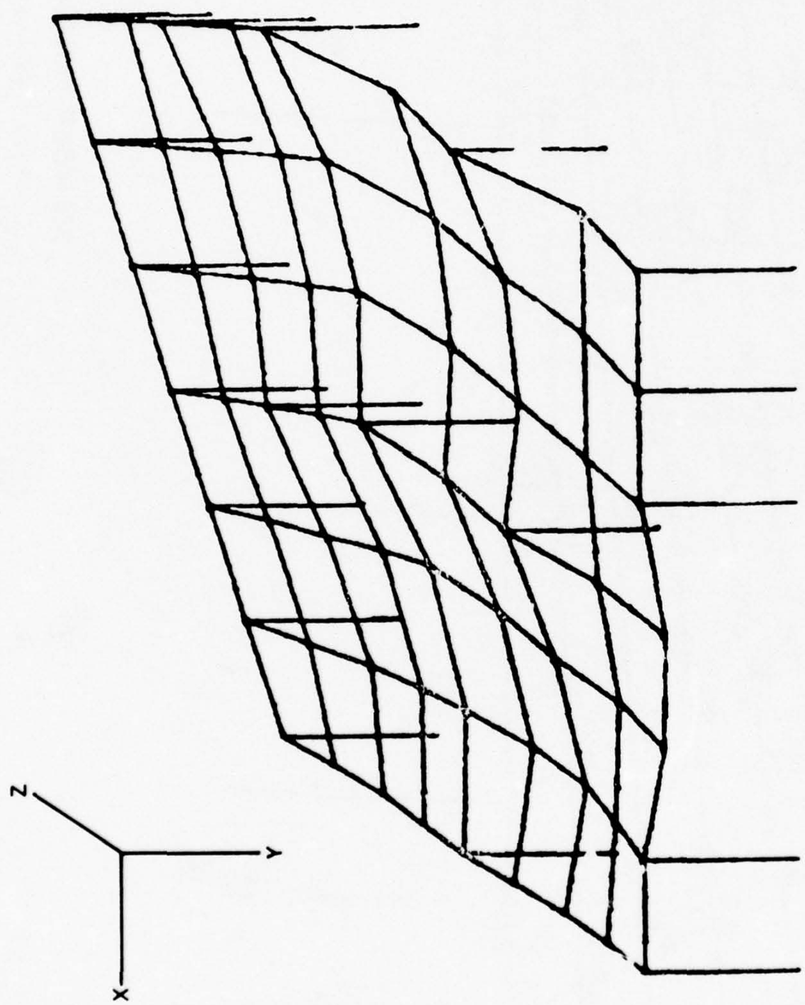
MEMBER NUMBERING SYSTEM

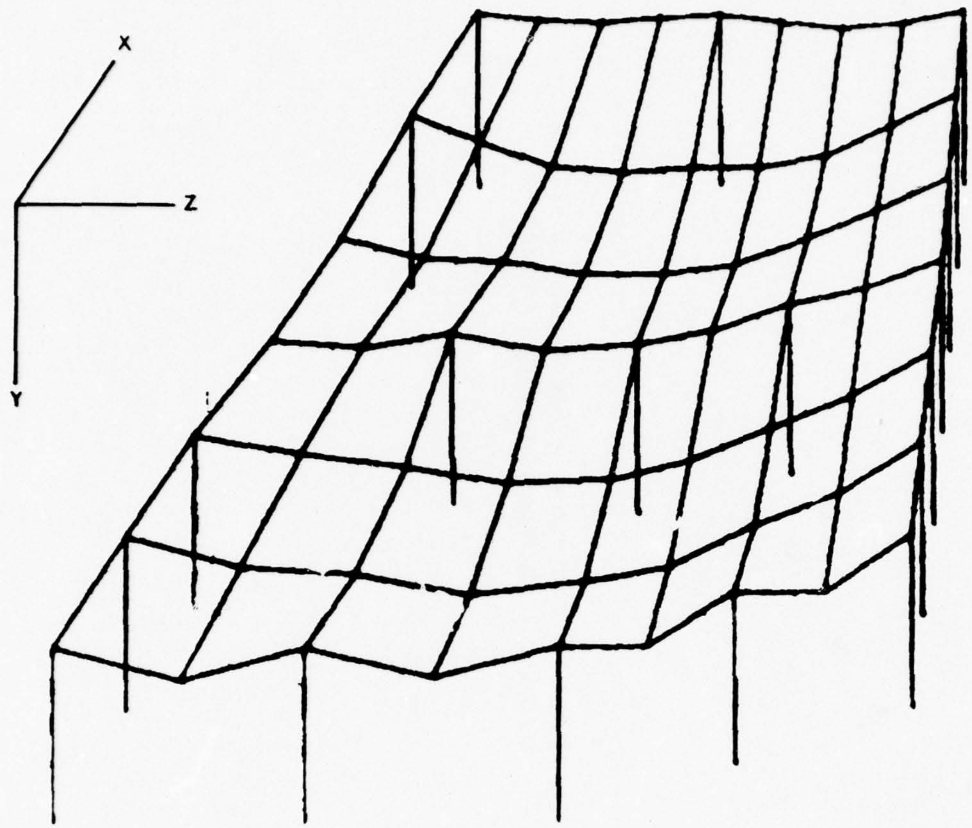
θX=20, θY=-170, θZ=-180

FULL D.L. AND L.L. ON ROOF SLAB

LOADING CASE 1

LATERAL VIEW





FULL D.L. AND L.L. ON ROOF SLAB

LOADING CASE 1

LONGITUDINAL VIEW

Appendix B: Abstracts of New England Division Structural Engineering Computer Programs

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM	PROGRAM NO.
Stability Analysis, Nonoverflow Gravity Dam - "DAMPAC"	713-F5-DO-100

PREPARING AGENCY

U. S. Army Engineer Division, New England, Corps of Engineers

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STATUS OF PROGRAM: STAGE
Paul R. Laliberte	June 1972		

A. PURPOSE OF PROGRAM

The program investigates sliding and overturning stability of a nonoverflow gravity dam section. As options, the program will increase the upstream slope or the depth of key in order to meet existing criteria. As a result, the most economical section may be found with a minimum of effort. Base pressures are also determined.

B. PROGRAM SPECIFICATIONS

The input is such that most any type of cross-section may be investigated, including one with a gallery. Water and earth can be located at any elevation on both the upstream and downstream sides. The structure may be on either a soil or rock foundation with or without passive pressure. Uplift reduction can be made.

C. METHODS

Conventional engineering techniques are utilized. The program has been prepared in accordance with criteria as set forth in EM 1110-2-2200 and ETL 1110-2-63. Standard programming methods in FORTRAN IV are used.

D. EQUIPMENT DETAILS

The program is written for a GE 427 (64K) computer and requires 4,644 words of memory in its present form. Components include an on-line card reader and printer and an off-line card punch.

E. INPUT-OUTPUT

Input is on punched cards and consists of a project title card, a station and case card, and pertinent data cards. Any number of stations and/or cases may be investigated.

Output provides a listing of descriptive data for the sections analyzed with an explanation of results.

F. ADDITIONAL REMARKS

The program has been successfully used for design of Trumbull Dam, Bloomington Dam, and the Lancaster Ice Dam.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM	PROGRAM NO.
Stress Analysis, Non-Overflow Gravity Dam	713-F5-D0-101

PREPARING AGENCY

U. S. Army Engineer Division, New England, Corps of Engineers

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STATUS OF PROGRAM: STAGE
Paul R. Laliberte	August 1971		

A. PURPOSE OF PROGRAM

The program computes end stress at any specified elevation within a non-overflow concrete gravity dam section. Stresses are also computed at the ends of an opening (i.e., gallery) if located at the elevation specified. Vertical and inclined compressive stress and shear stress are given as output.

B. PROGRAM SPECIFICATIONS

Pertinent data entered for the station includes the elevation at which computed stresses are desired. Force and stress computations are made for each elevation and followed by output of results.

C. METHODS

Conventional engineering techniques are utilized. The program has been prepared in accordance with criteria as set forth in EM 1110-2-2200 and ETL 1110-2-63.

Standard programming methods in FORTRAN IV are used.

D. EQUIPMENT DETAILS

1. The program is written for a GE 427 (64K) computer and requires 6,024 words of memory in its present form.

2. Components include an on-line card reader and printer and an off-line card punch.

E. INPUT-OUTPUT

Input is on punched cards and consists of a project title card, a station and case card, and pertinent data cards. Output provides a listing of descriptive data for the sections analyzed.

F. ADDITIONAL REMARKS

The program has been successfully used for design of Trumbull Dam.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM	PROGRAM NO.
3-Dimensional Stability Analysis, Nonoverflow Gravity Dam	713-F5-DO-102

PREPARING AGENCY

U. S. Army Engineer Division, New England, Corps of Engineers

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STATUS OF PROGRAM: STAGE
Paul R. Laliberte	August 1971		

A. PURPOSE OF PROGRAM

The program investigates sliding and overturning stability of a complete monolith with either a horizontal or irregular shaped base. The unsymmetrical projected base area is analyzed for sliding parallel and perpendicular to the base line. Overturning is about the two perpendicular centroidal axes. Base pressures are found.

B. PROGRAM SPECIFICATIONS

Pertinent data is entered for the end sections of the monolith. An iterative process is used to compute forces on the monolith. Water and earth elevations may vary on the upstream and downstream sides. Either a soil or rock foundation may be specified and can include passive resistance. Uplift reduction can be made.

C. METHODS

Conventional engineering techniques are utilized.

The program has been prepared in accordance with criteria as set forth in EM 1110-2-2200 and ETL 1110-2-63.

Standard programming methods in FORTRAN IV are used.

D. EQUIPMENT DETAILS

1. The program is written for a GE 427 (64K) computer and requires 18,669 words of memory in its present form.

2. Components include an on-line card reader and printer and an off-line card punch.

E. INPUT-OUTPUT

Input is on punched cards and consists of a project title card, a monolith and case card, and pertinent data cards. Output consists of descriptive data for the monoliths analyzed.

F. ADDITIONAL REMARKS

The program has been successfully used for design of Trumbull Dam.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM	PROGRAM NO.
Stability Analysis - Overflow Gravity Dam	713-F5-DO-105

PREPARING AGENCY
U. S. Army Engineer Division, New England, Corps of Engineers

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STATUS OF PROGRAM: STAGE
Paul R. Laliberte	June 1972		

A. PURPOSE OF PROGRAM

The program investigates stability of an ogee-spillway section. As options, the program will increase the upstream slope or the depth of key in order to meet existing criteria. As a result, the most economical section may be found with a minimum of effort. Base pressures are found.

B. PROGRAM SPECIFICATIONS

Any ogee weir section may be analyzed with the added option of a bucket downstream. The program also has provisions for a gated spillway, a gallery and various projections on the upstream side. Uplift reduction and passive pressure can be used.

C. METHODS

Conventional engineering techniques are utilized. The program has been prepared in accordance with criteria as set for th in EM 1110-2-2200 and ETL 1110-2-63. Standard programming methods in FORTRAN IV are used.

D. EQUIPMENT DETAILS

1. The program is written for a GE 427 (64K) computer and requires 5,598 words of memory in its present form.

2. Components include an on-line card reader and printer and an off-line card punch.

E. INPUT-OUTPUT

Input is on punched cards and consists of a project title card, a station and case card, and pertinent data cards. Any number of stations and/or cases may be investigated. Output provides listing of descriptive data for the sections analyzed.

F. ADDITIONAL REMARKS

The program has been successfully used for design of Trumbull Dam and Bloomington Dam.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.
EFFRAM - Analysis of Plane Frames on Elastic Foundations			713-F7-DO-110
PREPARING AGENCY			
U. S. Army Corps of Engineers, New England Division			
AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STAGE
P. R. Laliberte	July 1973		

A. PURPOSE OF PROGRAM

The program computes joint deflections and member end forces for plane frames which are subjected to joint loads and joint displacements. The structure to be analyzed may be founded on an elastic foundation. The program will compute the bearing pressure (non-linear) and will perform iterations to remove tension in the analogous spring foundation if desired.

B. PROGRAM SPECIFICATIONS

The program is restricted to 75 members and 55 nodal points.
The maximum nodal point difference is ten.

C. METHODS

Finite element techniques utilizing the direct stiffness method of matrix analysis is the basis for the program. The elastic foundations theory is based on Eduard Winkler's concept of analogous springs.

D. EQUIPMENT DETAILS

The program is written in FORTRAN IV and operates on a GE-400 Series Computer with approximately 23,258 words of memory.

Peripherals include a card reader, a disc drive and a page printer.
System software includes a date-time clock.

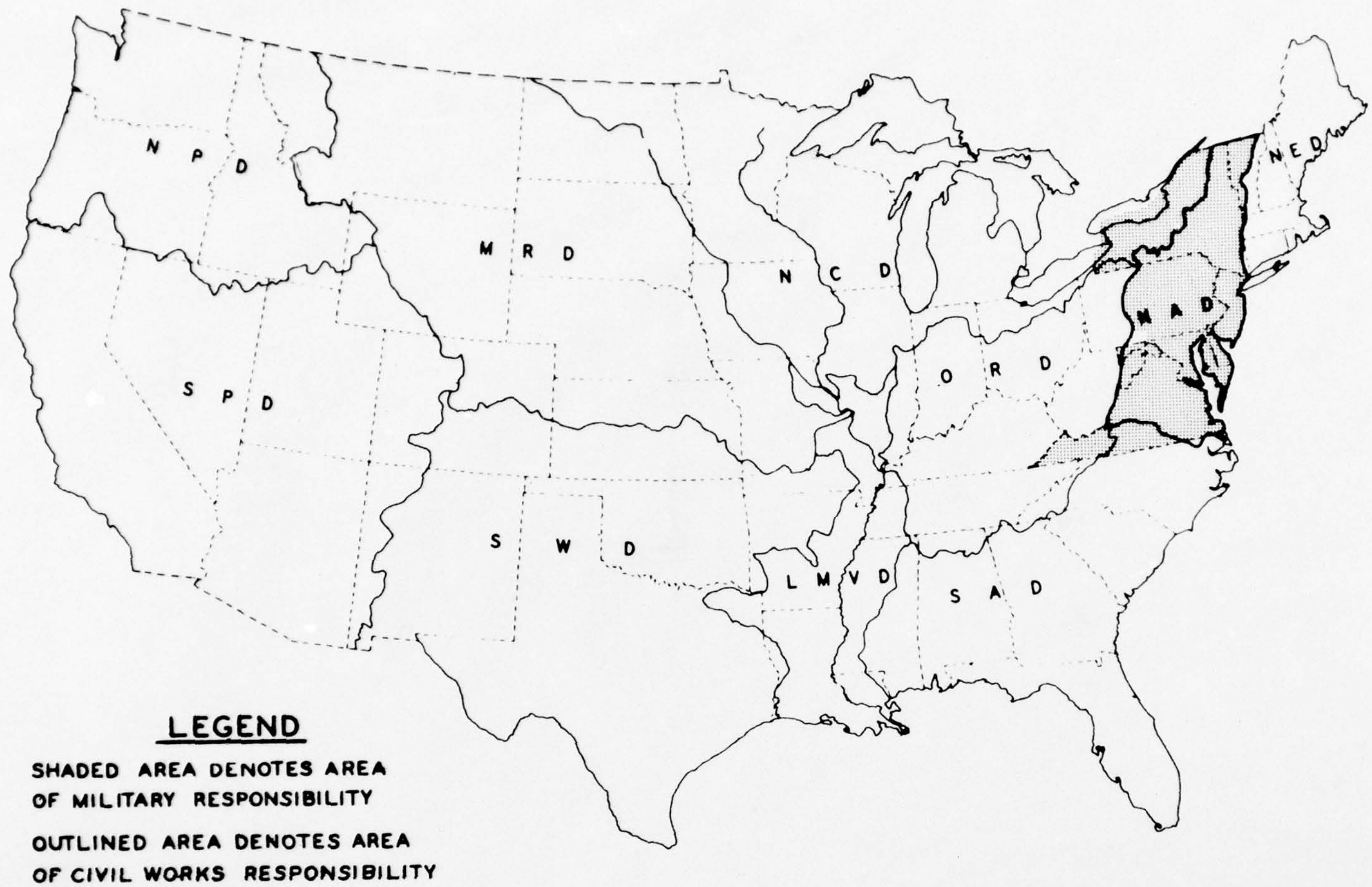
E. INPUT-OUTPUT

Input allows computations for any number of sections with any number of loadings. Output provides a listing of descriptive data for the plane frame, joint displacements, bearing pressures with location of compression and tension zones and member end forces.

F. ADDITIONAL REMARKS

1. Handles variable foundation conditions.
2. Foundation springs can be placed on any element.
3. Foundation springs may have one or two way action.
4. Foundation springs can be located on either side of the the element by reversal of the I and J node numbers.

NORTH ATLANTIC DIVISION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SHADED AREA DENOTES AREA OF MILITARY RESPONSIBILITY
OUTLINED AREA DENOTES AREA OF CIVIL WORKS RESPONSIBILITY

NORTH ATLANTIC DIVISION

by

Alvis I. Eikstrems*

The boundaries of the Civil Works mission in North Atlantic Division (NAD) differ from those of the Military Construction mission. The areas of responsibility here are determined by the basins of the major rivers in the area. New York District has the Hudson River; Philadelphia District, the Delaware River; Baltimore, the Susquehanna and the Potomac Rivers; and Norfolk, the James and Rappahannock Rivers. The military mission is divided among three Districts, New York, Baltimore, and Norfolk.

The location of NAD on the coastline of the Atlantic results in projects concerning beach erosion, navigation channels, canals with high-level bridges, and marine facilities. The marine environment dictates the occasional use of uncommon construction materials, such as aluminum, fiberglass, and corrosion-resistant alloys.

The Civil Works construction program also includes some large earth dams, such as Blue Marsh, Cowanesque, and Tioga-Hammond Lakes Dams in Pennsylvania, Bloomington Lake Dam in Maryland, and Gathright Dam in Virginia. Our recently completed Raystown Dam in Pennsylvania was the recipient of the 1974 Chief of Engineer's Award of Merit for engineering and design.

On the Military Construction side, the normal projects for barracks, mess halls, and family housing are supplemented by large showcase structures, such as the new Walter Reed Army Hospital, Harry Diamond Laboratories, and the United States Military Academy buildings at West Point. Included in the Military Construction program are also a number of projects for munitions production facilities at Radford Army Ammunition Plant, Virginia, and Picatinny Arsenal, New Jersey, with their particular design requirements.

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* Chief, North Atlantic Division (NAD). NAD oversees all the Civil Works and Military Construction in four Districts covering northeastern states.

Most of the structural design related to these projects is accomplished by Architect Engineer contracts. The in-house design effort is limited by manpower restrictions coupled with a large overall design responsibility. In FY 75, total Military Construction designed amounted to 230 million dollars; Civil Works construction cost 90 million dollars.

Data processing equipment in North Atlantic Division is probably very similar to that in most of the other Divisions. There is a Division Data Processing Center in Norfolk, Virginia, which we share with the New England Division. The Center is fully staffed and has a G-437 computer with peripheral equipment.

A second computer similar to the first is scheduled for installation to expand the capability for support of the Corps of Engineers Management Information System (COEMIS) mission. Other equipment includes a drum-type plotter, a COPE 1200 remote job entry (RJE), and time-share terminal equipment. The Center also services the Norfolk District requirements, as the District has no separate computer center.

The New York, Baltimore and Philadephia Districts each have a data processing center with G-225 computers and the necessary peripheral equipment. Each also has COPE 1200 RJE equipment. In addition, Philadelphia District has a drum- and flatbed-type plotter and New York District is scheduled to install a drum plotter in the near future. Located in various offices throughout the Division, including the Division Office itself, are a number of remote terminals for access to time-share computers. Structural engineers in each District have access to terminal equipment located in their Engineering Divisions. A terminal is scheduled for location in the Norfolk Structural Section.

The Division, as well as each of the Districts, has an Automatic Data Processing (ADP) coordinator. The coordinator supervises the activities of the Data Processing Center and is responsible for control and coordination in development of programs and procurement and use of ADP equipment and services. The data processing centers are staffed with ADP specialists, a number of them with engineering backgrounds.

With the development of COEMIS, the use of the computers in the District and Division ADP Centers for engineering design applications

has diminished, and more and more service contracts for time-share computer services have been concluded to support the engineering effort in the Districts. Among the services currently under contract to NAD Districts are: INFONET, Control Data (CYBERNET), General Services Administration (RAMUS), Waterways Experiment Station (WES) G-635 computer, Picatinny Arsenal computer, Fort Monmouth computer, Virginia Polytechnic Institute computer, and the Johnsville Naval Station computer.

Under current policy and procedures in NAD, the responsibility for encouragement and control in development of computer use for design lies with the District ADP coordinators. Much of this effort is accomplished by personal contact between the coordinators and sections chiefs of the various specialties. This personal contact is also the primary means of disseminating information about available programs and new developments in structural ADP applications. The publishing of available program listing occurs, but not on a regular or systematic basis. A recent publication in the Division is a booklet of program abstracts for programs current in the various District Offices.

The initiative for starting new developments lies with the section chiefs of the technical specialties. The structural section chief needs to identify design areas where computer use is applicable and economical. He then consults with the ADP coordinator, who attempts to locate the appropriate programs and have them adapted for use on available equipment or services. If no programs are available, development is initiated at the District ADP Center, with appropriate coordination and reporting to Division and higher authority. The effectiveness of this approach in practice varies with each District, and the personalities, backgrounds, initiative, and work loads of the personnel involved contribute heavily to the success or failure of these efforts.

The control procedures used for data processing management in NAD include: (a) submission of abstracts or application analysis to Division prior to initiation of programming, (b) reporting of all changes to Division disseminated programs, (c) reporting of all new contractual service arrangements, (d) coordinating with Division for availability of in-house ADP services at other Districts, and (e) maintenance and

reporting of job processing records. We find these control procedures satisfactory.

ADP training is the responsibility of each District personnel training officer. Guidance on Division ADP training needs is developed by the Division ADP coordinator and disseminated to the Districts. Offered in the current year are some courses on FORTRAN IV and orientation in time-share computer use.

The use of computers for structural design and analysis in NAD has been limited; currently only two of the four Districts have actual structural computer experience. Philadelphia District, with a large Civil Works design work load, has used computers in several designs and developed some programs. Of 15 engineers in the structural section, 6 have worked with computer design. The Philadelphia District Computer Center is being operated as an open shop to design engineers. Engineers are trained in the operation of the equipment; assistance in locating and adapting programs is provided by an ADP specialist who is a structural engineer. Subsequently, the engineers can and do operate the equipment themselves under the general supervision of the specialist. This approach seems to work very well and has had some success in generating interest in computer use.

Baltimore District has used and developed programs in both civil and military design. They have 11 structural engineers, all of whom have some degree of computer design experience.

There are a number of reasons for the low level of computer use for structural design in our Division and I would like to discuss some of them.

One basic reason cited by the engineer managers is the low volume of in-house design performed by the District. Also, the type and complexity of structures selected for in-house design do not appear to be suitable for computer use. The design of a single-story masonry building with a steel joist roof system and a slab on grade floor certainly does not justify computer application. Yet, the selection of the simpler buildings for in-house design is probably dictated by manpower limitations, combined with a large total volume of design responsibility.

Use of the computer would allow in-house design of more complex structures, but the computer experience is not there, due to simplicity of prior design. This is a tough problem for engineer managers to solve. It seems that a gradual development of computer experience with design of increasingly complex structures would be the answer. Certainly, development of design capability using computers is a desirable object in itself.

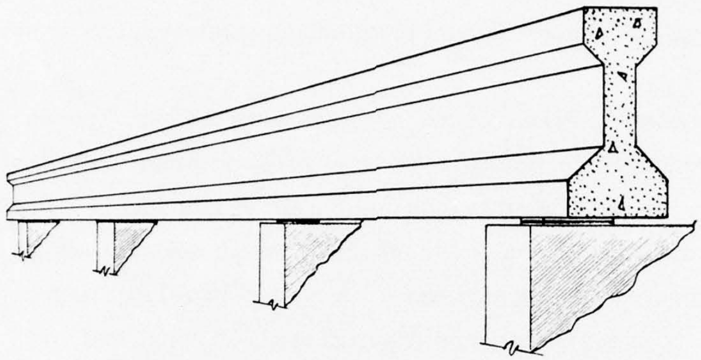
Another reason cited by engineers is the length of turnaround time needed for computerized analysis. Structural design, as you know, is a series of computations, each depending on the previous computation for input. Delay of one step results in the interruption of the whole design process. Turnaround time was a problem in the past, due to delays in preparation and transmittal of data and high priority COEMIS processing. Current use of time-share computer services provides the designer with a variety of processing speeds, including immediate computation. Perhaps this availability of immediate processing has not been communicated to the working level engineers. A possible third reason could be the lack of initiative of some older structural engineers in management positions. They may fail to apply data processing due to lack of familiarity with computer capabilities and lack of feel for the economies of computer use. Perhaps inadequate information is furnished the engineer managers on the availability of computer services and programs.

The lack of appropriate training in computer application could be another reason. Ideally, training should introduce the engineer to computer use in a gradual and logical manner.

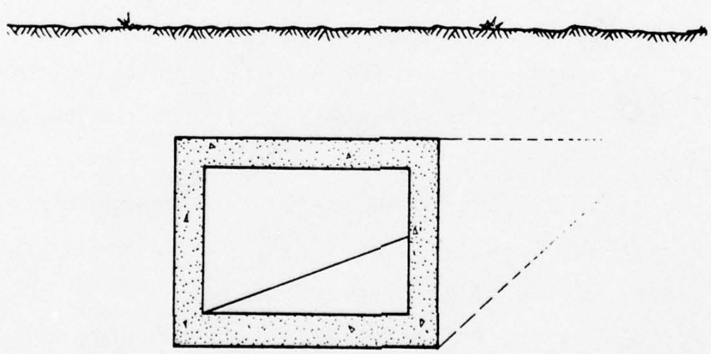
For Districts, which are well into computer use, timely identification of areas suitable for computer application in uncommon designs is a problem. By the time the appropriate computation is identified, it is too late to start development of a program without delaying the whole project. This problem will, of course, diminish as our computer libraries and familiarity with computer use increase.

The following programs represent recent computer experience in NAD:

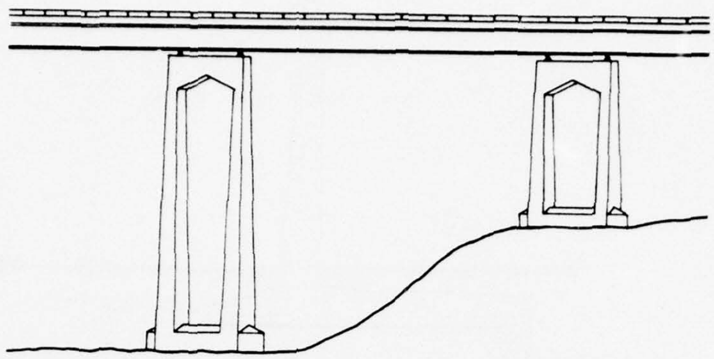
a. Continuous girder analysis. This is a bridge design program developed at GE and available on the GSA time-share G-440 computer. The program was used in the design of two highway bridges on the Blue Marsh Dam highway relocation project. Philadelphia District has no adverse comments on this program.



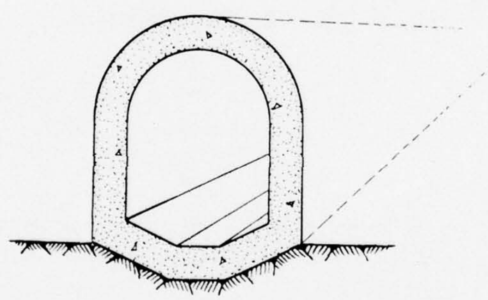
b. O-frame. This program uses stiffness matrix method to analyze a planar orthogonal structure. The program was developed at Memphis District and is available on the WES G-635 computer and on the GSA time-share G-440 computer. The program is being used on the design of a box culvert structure on the Blue Marsh Dam project, for the Bernsville Protective Works.



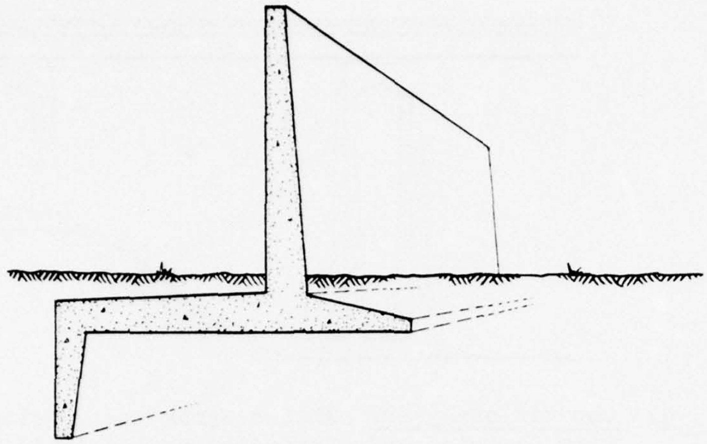
c. Concrete column analysis, biaxial. This program was developed by the Philadelphia District for design of bridge piers on the Tocks Island Dam highway relocation project. The program provides reinforcing and concrete stresses and location of neutral axis, based on the method presented in Appendix D of the 1963 AASHTO Standard. Both the method and the project are no longer valid.



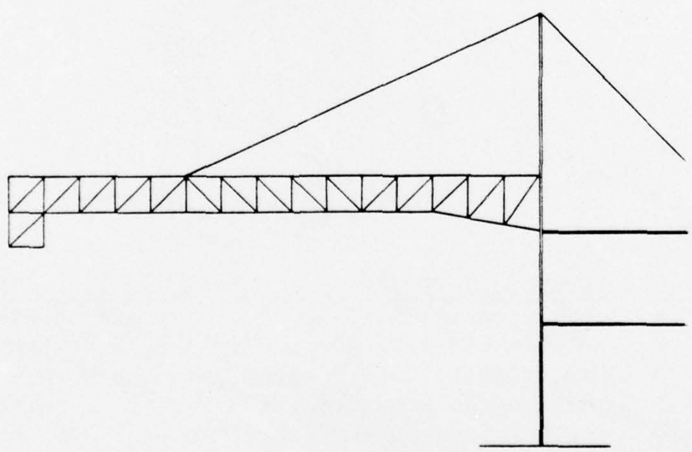
d. Conduit analysis. This program was developed by Kansas City District and adapted by Philadelphia District for use on the Blue Marsh Dam project. The program uses the method described in EM 1110-2-2902. Usable on GE-225 computer. No adverse comment.



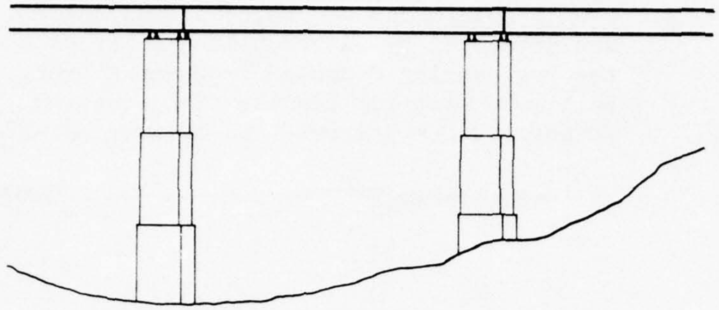
e. Inverted T-floodwall stability design. This program was developed by Galveston District and adapted by the Philadelphia District for preliminary investigation on Trexler Dam project. The program computes a wall section, earth and seepage pressures, and factor of safety against sliding. Philadelphia District uses it on the INFONET time-share computer and has found its performance satisfactory.



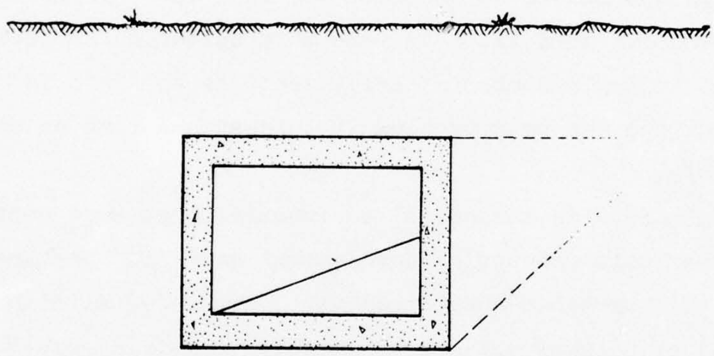
f. Determinate truss analysis. This program was developed by the Baltimore District and has been included in the WES Computer Programs Library. It was used in the design of the Aircraft Maintenance Facility at Ft. Meade and the Commissary at Ft. Knox. The input is joint definition by coordinates and load identification. The output gives reactions and member stresses. The program is written for use on the GE-225 computer.



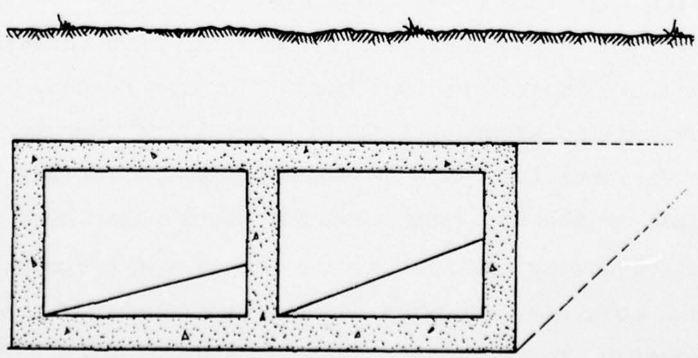
g. Railroad bridge pier. This program was developed by Nashville District and used by Baltimore District to check a design prepared for a railroad relocation project on Bloomington Lake Dam design. Further use of the program for design was found not to be advantageous because input required extensive preliminary design. Usable on the GE-225 computer.



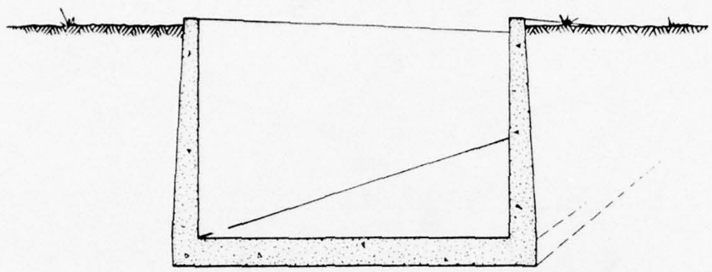
h. Box culvert design--one cell. This program was originated by Vicksburg District and adapted by Baltimore District for use on the Bloomington Lake Dam design, highway relocation project, and preliminary design for the Tioga-Hammond Dam design memorandum. Usable on the GE-225 computer. No adverse comment.



i. Computer analysis of twin box culverts. This program was developed by Rock Island District and adapted by Baltimore District for use on the Bloomington Lake Dam design, highway relocation. The adaptation involved updating to current criteria. Usable on the GE-225 computer.



j. <u>U-wall reinforced concrete channel design.</u> This program was developed by San Francisco District and is included in the Engineering Computer Programs Library. To be used by Baltimore District for the flood control portion of the Cowanesque Dam project. To be used on WES G-635 computer.



A general criticism expressed on some other programs investigated for use by the Baltimore District was that these programs were not design oriented. That is, they were more suitable for review. The requirement to try a number of trial sections to "zero in" on the most economical one can be a problem if turn-around time on computation is appreciable.

Some areas in structural engineering that were mentioned as needing further data processing development are: (a) prestressed girder design, (b) horseshoe-shaped conduit design, (c) sliding analysis of walls and structures subject to lateral loads, (d) earthquake investigation, and (e) shear wall design.

Of the problems encountered in computer use, the most prominent one was the turnaround time problem. Others mentioned were delays due to wait for card punch equipment availability and lack of up-to-date program listings from other Districts.

While the structural designers in NAD have achieved some computer experience, it is evident that more effort is needed. I believe that an improvement in procedures for disseminating computer information would be very helpful. The information should include not only listing of programs or abstract packages, but should also give brief discussions on actual economies achieved by the use of the program, the design improvements obtained, the good and the bad points of the program, and recommendations for equipment use. A Division-wide effort for computer

training of structural engineers is desirable. This should include familiarization with available equipment, review and analysis of available structural programs, and a discussion of methods for recognizing areas of structural design suitable for computer application and development. The emphasis should be on application-type training.

The development of new programs should be done at the Districts on their own initiative. However, the working structural engineers, not just ADP personnel, should be intimately involved in this development. There should be an effort to develop a Division Computer Programs Library for Division-wide applications. This, together with the WES library, would provide the structural engineers with a powerful tool for use in design. If manpower and expertise are available, I would like to see a procedure established for periodic program review at the Division level by computer-oriented engineers in various specialties. Currency of these programs could then be assured and improvements or modifications could be suggested to the District that developed the program. More use should be made of computers in review of Architect Engineer structural designs.

Computer hardware and time-share service contracts in the Division should be standardized as much as possible to facilitate communication and interchange of information and programs. Time-share terminals should be made available to the structural engineers in their own sections, and an adequate number of time-share contracts should be concluded by each District to allow use of available programs.

It is my feeling that the organization of this conference, with its wealth of structural computer information and the interchange of experience and ideas among structural engineers, is exactly the effort needed from the Office, Chief of Engineers (OCE), to encourage and improve the use of computers in structural engineering. I feel certain that the results will be noticeable in NAD. I would not be surprised if this conference marks the starting point for a comprehensive structural ADP effort in quite a few Districts.

Another OCE/WES effort I applaud is the publication and dissemination of the WES Engineer Computer Notes. I find this an informative

and valuable publication for keeping engineers current on changes in the Corps computer policies and on new developments in data processing.

I would like to see further expansion of the structural portion of the Engineering Computer Programs Library at WES and the availability of a conversationally oriented program-generating system in structural engineering. Another improvement I am looking forward to is the availability of a structurally oriented subsystem, such as STRUDL, to structural engineers in the Districts. This availability should be supplemented by appropriate training at the District level.

Appendix A: Abstracts of North Atlantic Division Structural Engineering Computer Programs

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM	PROGRAM NO.
Continuous Girder Analysis	

PREPARING AGENCY

General Electric Company

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM — PHASE	STATUS OF PROGRAM — STAGE
Charles M. Tilly	1966		OP

A. PURPOSE OF PROGRAM

Determines the reaction, shear, and bending moments in a continuous beam, due to a unit load. This program will analyze any type of continuous structure or structural element used in highway design or building construction.

B. PROGRAM SPECIFICATIONS

FORTRAN Batch.

C. METHODS

The program will accomodate a configuration of up to five spans. The effort of settlement of any of the beam supports can be factored into the analysis of the beam. Up to fifty changes in the moment of inertia of the beam will be accepted.

D. EQUIPMENT DETAILS

Honeywell G-400	G-600/6000
Card reader	Card reader
Printer	Printer
4 Magnetic tapes	2 Magnetic tapes

E. INPUT-OUTPUT

Input - CARD

Output - Printer and tape

F. ADDITIONAL REMARKS

Complete documentation available in Honeywell (formerly General Electric) manual, Order Number BQ27 (formerly CPB-1273).

AD-A031 246 ARMY FOREIGN SCIENCE AND TECHNOLOGY CENTER CHARLOTTE--ETC F/G 9/2
CORPS-WIDE CONFERENCE ON COMPUTER-AIDED DESIGN IN STRUCTURAL EN--ETC(U)
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ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.
Multiple Load Case Planar Orthogonal Frame Analysis (OFrame)			713-G9-A1-030
PREPARING AGENCY: U. S. Army Engineer District, Memphis			
AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STAGE
Robert E. Brittain	April 1970	Init	OP

A. PURPOSE OF PROGRAM

This program determines the joint displacements and rotations, member end moments and shears, and structural reactions for planar orthogonal frames. The program is adaptable to solutions of continuous beams or box culverts as well as frames.

B. PROGRAM SPECIFICATIONS

The program is written in conversational FORTRAN.

C. METHODS

The program utilizes the stiffness matrix method for solution of joint displacements and rotations. The Cholesky decomposition method is used for solution of the resulting simultaneous equations using only the lower half-band of the coefficient matrix which is stored in a linear array. Structural reactions are determined by summation of forces and moments at the supports. Axial deformations are neglected by the program.

D. EQUIPMENT DETAILS

The program is written for the BE-430 time-sharing system which includes a Datanet 30, disc units, tape handlers, high speed printer, card reader, and card punch. User input and output to the system is by means of Teletypewriter Model 33.

E. INPUT-OUTPUT

Input consists of displacement number designation at each joint, geometry of each member, and loading on each member and each joint for each loading condition. Output consists of an input data check, error messages, joint displacements, member end moments and shears and reactions.

F. ADDITIONAL REMARKS

External disc storage is used for input data file.
Object size is 11,624 words.
This program is one of three programs developed for structural analysis. The other two are Planar Frame Analysis (713G9A1040) and Planar Pinned Truss Analysis (713G0A1050).

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.
Concrete Column Analysis, Biaxial			713-F5-E5-020
PREPARING AGENCY: U. S. Army Engineer District, Philadelphia			
AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STAGE
Carl Doughty	February 1974		

A. PURPOSE OF PROGRAM

This program analyses reinforced concrete columns subjected to an axial load and moments about each axis. The stresses at critical locations in the concrete section are computed, as well as the maximum and minimum steel stresses. All computations are based on Working Stress Design (WSD) assumptions.

B. PROGRAM SPECIFICATIONS

Program written in FORTRAN IV (Time-Sharing).

C. METHODS

If NO ANGLE is given for neutral axis, one is computed from the section geometry and the applied moments. The neutral axis is moved across the section in one inch increments, and the stresses are computed for each location of the axis. This is continued until the concrete stresses in the uncracked section are all compressive. At this point, the stresses are printed and the analysis is complete. After each analysis, a new neutral axis angle or a new column may be entered.

D. EQUIPMENT DETAILS

Remote Interactive Terminal (such as Teletype) connected to GE-435 or GE-600 Computer System (or BE-437 computer for Batch Processing Modification).

E. INPUT-OUTPUT

Input - Concrete section geometry, including location and sizes of re-bars (inches, square inches). Axial load (Kips) and moments (IN-KIPS). Steel/Concrete stiffness ratio (N). Angle of assumed neutral axis (Optional) (Degrees).

Output - Stresses at extreme points of uncracked section, maximum and minimum steel stresses (KIPS/SQ. IN.).

F. ADDITIONAL REMARKS

The program is being developed to work in an interactive mode using a time-sharing system. Slight modification of the input routines would make it usable for Batch Mode Processing.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.
Circular and Oblong Conduit Design			713-R3-C122
PREPARING AGENCY Kansas City District, Corps of Engineers, ADP Center, 601 East 12th Street, Kansas City, Missouri 64106			
AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STATUS OF PROGRAM: STAGE
Marion M. Harter Byron E. Bircher James L. Goering	January 1968	Init	Rep

A. PURPOSE OF PROGRAM

This program will perform a design or review analysis for any given sized circular or oblong conduit. The conduit loads, geometry, structural and stress (working and ultimate strength) analysis with either uniform or triangular base pressure are computed by the program. In addition to reinforcement requirements, the program will determine the minimum conduit wall thickness.

B. PROGRAM SPECIFICATIONS

The program is written in FORTRAN II with eight program links for a 40K Central Processor.

C. METHODS

Draft to EM 1110-2-2902, dated March 1966. (ACI 318-63) Building Code.

D. EQUIPMENT DETAILS

The data processing system consists of a 40K Central Processor with the following on-line equipment: card reader, 4-reel magnetic tape unit, and printer.

E. INPUT-OUTPUT

Input is on cards.
Output is by the printer.

F. ADDITIONAL REMARKS

Program write-up is not available.
This program has been revised to run on the Honeywell G-437. Program number 713-F5-C1-01B.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.
Inverted T Floodwall Stability Design			713-G1-M3-060
PREPARING AGENCY: U. S. Army Engineer District, Galveston (Structural Section)			
AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STAGE
R. Veselka R. R. Petter	Sept 1967	Operational	

A. PURPOSE OF PROGRAM

To select the minimum base width for an inverted T floodwall, in accordance with the requirements of EM 1110-2-2501. Overturning and sliding are considered, both with and without the inclusion of surcharges and concentrated loads used to represent wave force loading. The program can also be used for analysis of a given base width.

B. PROGRAM SPECIFICATIONS

713-G1-M3-006 uses GE-200 series Card FORTRAN. Supplements A and B use GE-200 series FORTRAN IV, but can be adapted to FORTRAN II without difficulty.

C. METHODS

Based on EM 1110-2-2501 criteria. Sliding uses a wedge analysis. Different soils data are used for overturning with save force, overturning without wave force, sliding with wave force, and sliding without wave force (generally the unconcolidated-undrained shear strength with wave force and consolidated, drained or undrained, without). Seepage unlift can be ignored if desired and program will design for one condition and analyze for the other.

D. EQUIPMENT DETAILS

Required for execution:
GE-200 series central processor with 8K memory (GE-225 for supplements A or B)
High Speed Printer Card Punch (for supplements A or B).
Card Reader, 1 Tape Handler (for supplements A or B with no source job option)
Console Typewriter (for supplements A or B).

E. INPUT-OUTPUT

Input - on cards: Problem label, descriptions of finished grade, wave force, soils data, elevation of toe, slope of base, stem ratio, min. creep ratio, option selections.

Output - on high speed printer: Program label, data echo check, description of wall, earth and seepage pressures, factors of safety against sliding, all with and without wave forces.

F. ADDITIONAL REMARKS

Supplement A computes an estimated construction cost and survey report drafting dimensions. It uses cards punched by the main program as data and outputs on the high speed printer.
Supplement B computes special input data cards to enable the main program to use a water level below the top of the wall. Input is on cards, output is on both cards to feed the program and on the high speed printer.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.
Determinate Truss Analysis			713-F7-E4580
PREPARING AGENCY			
U. S. Army Engineer District, Norfolk			
AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STAGE
David S. Heindel	November 1963		

A. PURPOSE OF PROGRAM

Program solves a simple, statically determinate, pin-connected truss for the support reactions and axial stress in each member.

B. PROGRAM SPECIFICATIONS

FORTRAN II

C. METHODS

Truss is defined by gining the coordinates of each joint and listing members connecting these joints. The structure may be statically loaded at any of the joints. Program is limited to trusses that can be analyzed by the method joints. A maximum of 425 members can be used. Any number of loading conditions can be treated without rereading the truss configuration.

D. EQUIPMENT DETAILS

GE-225, 8K, CR, HS Printer

E. INPUT-OUTPUT

Input - Structure and load descriptions via cards.

Output - Tabulation of truss end reactions and internal stresses.

F. ADDITIONAL REMARKS

Program was obtained from the IBM 1620 General Program Library and converted for use on the GE-225. At present, only trusses with a maximum of 245 members can be solved. However, the capacity of the program could be increased depending on available memory.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.
Box Culvert Design - One Cell			713-G9-A4-060
PREPARING AGENCY			
U. S. Army Engineer District, Vicksburg			
AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STAGE
Walter T. Miller and Richard C. Davis	May 1971		

A. PURPOSE OF PROGRAM

To determine the minimum thicknesses of the horizontal and vertical members and the area of reinforcing steel to provide for moment and the required factor of safety for cracking load for shear.

B. PROGRAM SPECIFICATIONS

For a maximum of thirty loading conditions the program will find the minimum thicknesses required to support the load or it will compute the resulting stresses, d's, steel reinforcing and factor of safety in the members. The program does not compute for haunches. Backfill is considered to be level over the completed structure.

C. METHODS

The design is in accordance with the criteria set forth in EM 1110-2-2902. Distributed moments are adjusted to the column face and at the center of the span by the method explained starting on page 28 of Continuity in Concrete Building Frames, Practical Analysis for Vertical Load and Wind Pressure, fourth edition, published by the Portland Cement Association.

D. EQUIPMENT DETAILS

The program is written in FORTRAN IV for GE 400 Series computers

E. INPUT-OUTPUT

Input consists of 6 types of cards in the following sequence: (1) User ID. One time only, (2) Title card. One per culvert, (3) Comment card. Optional, (4) Constants. One per culvert, (5) Case title. One per case, and (6) Case data. One per case. The input setup should include as many pairs of case title and case data cards as there are loading conditions.

(continue)

F. ADDITIONAL REMARKS

E. INPUT-OUTPUT (continued)

Output consists of:

(1) Recap of input and thicknesses of members.

(2) Adjusted moments, thrust, and shears for external, internal and hydrostatic head loadings.

(3) Maximum shear, maximum moment, thrust for load producing maximum moment, Nd"/12, steel moment, required d's, provided d's, equivalent areas of steel, equivalent areas of thrust and the areas of steel reinforcing for each of the seven points inspected.

(4) For horizontal members the resulting safety factor for cracking load, safety factor required and the distance between points of contraflexure for both maximum and external loading.

(5) The above information is given for either one or two factors that control vertical soil loading for each case. At the end of the design analysis a summary sheet gives the maximum thickness required in each member, maximum steel area for reinforcing at each design location, range of contraflexure in each horizontal member and cross sectional area of concrete.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM	PROGRAM NO.
Computer Analysis of Twin Box Culverts	713-GI-F438A

PREPARING AGENCY

Iowa State Highway Commission

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM — PHASE	STATUS OF PROGRAM — STAGE
I. S. H. C.			

A. PURPOSE OF PROGRAM

Analysis of twin barrel reinforced box culverts.

B. PROGRAM SPECIFICATIONS

American Association of State Highway and Transportation officials specifications.

C. METHODS

Moment distribution.

D. EQUIPMENT DETAILS

Minimum requirements include 8K words, card input, and line printer output for FORTRAN II.

E. INPUT-OUTPUT

Input is a description of geometry and loading.
Output provides required wall thickness, bar areas, and bar cut-off points.

F. ADDITIONAL REMARKS

Program has been used extensively in highway relocations of Iowa roads.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.
U-Wall Reinforced Concrete Channel Design			713-G2-L3-001
PREPARING AGENCY			
U. S. Army Engineer District, San Francisco			
AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STATUS OF PROGRAM: STAGE
J. D. Helmich	September 1969	INIT	REP

A. PURPOSE OF PROGRAM

This program provides a rapid method of design for a cross-section of a reinforced concrete U-walled channel. Also provided as an option is a plot routine for graphs of the reinforcing steel requirements of the channel.

B. PROGRAM SPECIFICATIONS

FORTRAN IV (H)

C. METHODS

The program utilizes a direct method of solution for the thickness and reinforcing steel requirements of the wall and an iterative solution for the geometry of the base slab. Elastic structural analysis is applied calculated on the basis of a rigid structure on a rigid foundation.

D. EQUIPMENT DETAILS

IBM 360 (128K bytes) or GE-145 (32K words) or comparable configuration including card reader, printer; off-line keypunch for data preparation.

CID Incremental Plotter (for optional plotted O/P)

E. INPUT-OUTPUT

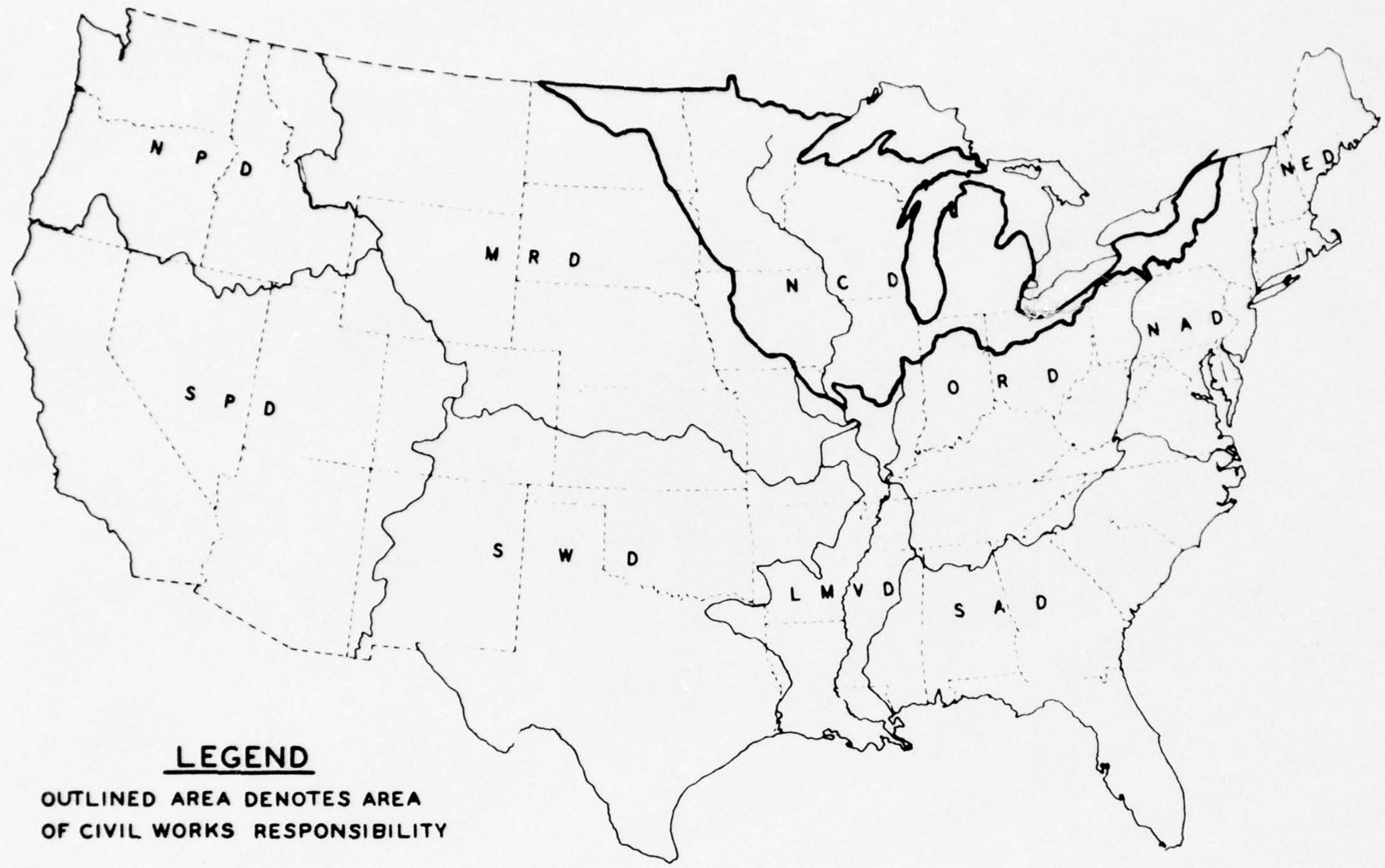
Input is via cards punched from input from SPN 540.

Output is via printer with an optional plot which graphically displays the maximum wall and slab steel requirements. Output consists of slab data, data for heel, soil pressure and final concrete dimensions for channel.

F. ADDITIONAL REMARKS

Plot option is called by routines which are an integral part of the program. In order to use plot option, Benson-Lehner Plot software package with modifications is necessary. Request Program No. 803-G2-L3-000 (Plot Package).

NORTH CENTRAL DIVISION


N P D
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LEGEND
OUTLINED AREA DENOTES AREA
OF CIVIL WORKS RESPONSIBILITY

COMPUTER APPLICATIONS TO STRUCTURAL ENGINEERING IN THE NORTH CENTRAL DIVISION

by

John P. D'Aniello*

I would like to take this opportunity to present the specific experience which we in NCD have had concerning the development and use of the computer as a design tool. Our experience in the use of computer-aided design has been favorable. However, certain hardware and software problems have caused inefficiencies in our use of the computer. I will discuss these problems along with suggested remedies for consideration, a brief description of our designs, and specific applications of computer-aided design techniques which have been used recently.

The NCD is made up of five Districts: Buffalo, Chicago, Detroit, Rock Island, and St. Paul. It extends from New York to North Dakota, encompassing the Great Lakes, the St. Lawrence Seaway, the Upper Mississippi River Basin, and the Illinois Waterway. Our division is concerned with civil works projects for the entire Great Lakes and Upper Mississippi River area.

With almost 4000 miles of shoreline, one of our major concerns is the design of coastal structures on the Great Lakes. These structures consist of various types of harbor structures for both commercial and recreational harbors. In addition, the 4000 miles of shoreline is subject to erosion and flooding. This has been especially severe in recent years due to the record-high levels of the Great Lakes. Tremendous forces, exerted by both the severe wave climate and the presence of winter ice on the lakes, complicates the design of these coastal structures.

Numerous flood control projects have been constructed incorporating a variety of types of structures in NCD. The St. Lawrence Seaway, the connecting channels of the Great Lakes, the Illinois Waterway, and

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the Upper Mississippi River provide a navigation system which serves the entire north-central portion of the United States. This navigation system consists of more than 40 locks and dams which NCD has designed or is responsible for. The confined disposal program on the Great Lakes, which was initiated in 1970 to confine polluted dredged material, has introduced some unique structural design problems.

These design concerns, coupled with the typical designs of a civil works program, have presented a variety of problems to the structural engineer. Our engineering and design program in FY 75 was approximately $23 million of which approximately $7 million was spent on engineering contracts. Of the $16 million spent on in-house design, approximately $550,000 or 3.4% was spent for computer use for engineering design.

The applications of the computer in NCD to structural design are quite varied. Both analysis and design have been performed by computer for almost all aspects and throughout all phases of the design effort from preliminary planning through postconstruction analysis of existing structures.

Recently, numerous types of structures have been constructed which were designed through use of the computer. These include: (a) bridge design, (b) culvert design, (c) I- and T-wall flood control structures, (d) steel sheet pile harbor structures, (e) pumping station design, (f) reinforced concrete pipe design, (g) analysis of existing structures, and (h) miscellaneous designs. The programs used in these designs are listed for reference with their respective program numbers in Appendix A.

Numerous highway and railroad relocations were designed using computer-aided design techniques. Design of the Saylorville Project involved numerous bridge relocations which were designed using computer-aided techniques. Specifically, the State Highway 89 Bridge and the Milwaukee RR Bridge were two relocated bridges.

Highway 89 Bridge is a 1000-ft, 5-span continuous plate girder highway bridge which was designed using computer-aided design techniques. Numerous programs, which were developed at the Rock Island District, were used in this design. These include INFORD, which provided

influence lines, moments, and shears in accordance with AASHTO loads. GIRD1 and GIRD2 are two programs which were used to analyse both the composite and noncomposite girder sections. In addition, a program entitled "Analysis of Bridge Piers--AASHTO" was used to design the bridge piers.

The Milwaukee RR Bridge was designed primarily through the use of four programs: (a) Analysis of Moving Loads (WTRAIN), (b) Analysis of Plate Girder--AREA Specs, (c) Analysis of Telescopic Bridge Pier--AREA Specs, and (d) Concrete General Flexure Analysis.

In addition to these bridge designs, preliminary designs for some 15 bridges on the Illinois Waterway were performed for the Duplicate Locks Project using STRUDL, a subsystem of ICES developed at MIT. Through the use of this system, preliminary designs were developed using only two computer runs per bridge. This led to a tremendous design savings.

A second computer application has been the design of culverts. One example of this was the computer-aided design for the Saylorville Project; this incorporated the "Concrete Box Culvert Frame Analysis and Design Program" in the design of this Saylorville Dam conduit. This program analyzes culverts and conduits under high fills and provides the engineer with the required design data.

Numerous I-wall and T-wall flood control structures have been designed with the use of various different computer programs. The Flint River Flood Control Project used the "T-Type Retaining Wall" analysis to design these structures. Unusual loading conditions were encountered in many instances where these flood control structures were in highly industrialized areas. Other examples are the Dubuque Local Flood Protection Project, and the Mankato Flood Control Project.

Computer programs were extensively used to design steel-sheet pile anchored walls used in rehabilitation of existing deep-draft harbor structures. Specifically, the "Sheet Pile Multi-Layer Design with Tieback" program was used to analyze the pier at Rochester Harbor.

Three separate programs were used to analyze and design the rehabilitation of the South Haven Harbor Structure. A program entitled

"Newmark Numerical Method" was used to design the front wall; "Miscellaneous Steel Design" was used to design the wale, tie rods, and connections; and "SSP Continuous Anchor Wall Design" was used to design the anchor wall. In addition, where the anchor wall is not a sufficient distance behind the front wall to develop the total passive wedge, a program entitled "Packshaw Method of Design for SSP Backwall," developed in the Detroit District, is used to design the anchor wall.

These programs along with other adaptations have been used for the design of many additional steel sheet pile structures. Two computer programs developed in the Buffalo and Detroit Districts were used in the design of the storage dock at Calumet Harbor and the strengthening of the existing pier at Kenosha Harbor. The Kenosha Project incorporated the use of battered earth anchors.

Another computer application is in the design of pumping stations. The stiffness method "Frame" program along with the "Pile Foundation Analysis by Hrennikoff" were used to design the pumping station at the Clinton Flood Control Project.

Another application is for the design of reinforced concrete pipe. One example was the design of this pipe, using three computer programs, for the Clinton Project. These programs design RCP pipe in accordance with the RCP manual.

Another important application of the computer has been the analysis of existing structures. A complete analysis of the existing locks on the Illinois Waterway was performed. This analysis employed three programs: (a) "Lockwall Analysis," (b) "General Wall Stability Analysis," and (c) "Finite Element Analysis."

"Lockwall Analysis" is a 2-dimensional analysis which was developed in the Chicago District; it analyzes the stability of the typical wall monoliths in accordance with EM 1110-2-2602. "General Wall Stability" is a 3-dimensional analysis which was used to analyze the stability of the gate blocks and other asymmetrical monoliths. This program was developed in the Buffalo District and adapted by the Chicago District for this purpose. Internal lock stresses were analysed by use of the "Finite Element Analysis" developed at the University of California.

The output from this program was adapted for the Calcomp plotter to graphically display the stress patterns which exist within the structures. The outputs, showing principal stresses, tensile stresses, and deflections, were developed at the Chicago District for this purpose. In addition, numerous existing bridges were rated using computer programs obtained from the Association of American Railroads Research Center (AARRC); these are based on the 1967 AREA Specifications.

In addition to the applications mentioned above, numerous miscellaneous designs have been prepared using computer-aided techniques. A few examples are the designs for numerous excavations, control towers, U-structures, various types of closure structures, and numerous gate wells.

During the design of these structures many problems have surfaced in the development and use of the computer as a design tool. These problems can be grouped into two general areas, hardware and software problems. The most significant hardware problems have been: (a) the nonavailability of computer time on the G-225/437 and (b) the inefficiency of the batch mode of operation.

During the past 5 yr substantial strides have been reached in NCD in obtaining the hardware necessary to provide the engineer with efficient computer availability. The use of both the G-225 and G-437 for structural engineering applications has rapidly declined in the recent past. The primary reason for this decline has been the poor responsiveness of these computers. Turnaround times for these machines has gradually increased to the point where two to three day turnaround time is not unusual for the periods of the month when the COEMIS F&A subsystem is being run. Use of the time-sharing mode of computer operation has steadily been increasing; for the most applications, the overall efficiency of the design engineer far outweighs the additional computer costs involved. The effort to obtain additional hardware for new developments in the field, such as computer graphics, must be continued.

The development of computer capability within NCD to date has consisted primarily of a process by which each District has obtained a group of programs which it uses for structural analysis and design.

From a development standpoint these programs fall into four general categories: (a) programs which were developed within the District itself, (b) programs which were developed by other Districts but adapted for application to a particular problem, (c) program developed and maintained completely by an outside agency, and (d) proprietary programs.

We have found that each type has its advantages and disadvantages. Some advantages and disvantages of each are as follows.

The internally developed programs solve the problem at hand and are easily adapted, but development time is high and there are high maintenance costs.

Externally developed, internally modified programs have less costly development and solve the problems at hand, but sometimes lack documentation, have questionable verification, limited application, high adaptation time, and high maintenance costs.

Outside agency programs usually have good documentation, complete verification, are generally easy to use, and have low maintenance. However, they are sometimes inefficient and are generally not adaptable.

Proprietary programs have good documentation, are easy to use, cover a variety of applications, have no development cost and no maintenance cost. They are not adaptable and are expensive to use.

During this development, software problems arising and currently existing within the Districts, have caused inefficiencies in using the computer as a design tool. The problems can be classified in the following six categories: (a) uncontrolled development Corps-wide, (b) absence of centralized verification, (c) nonavailability of a centralized user information center, (d) nonavailability of user manuals, (e) lack of centralized maintenance, and (f) lack of knowledge.

To date NCD has encouraged District level program development for internal use. This policy so far has led to substantial positive results in the use of the computer as a design tool, but much duplication within NCD. Duplication appears to be even more evident on a Corps-wide basis.

This duplication has resulted in a second problem, lack of verification for all these available programs. In many cases verification

of a program is either not documented or not apparent and a user receiving a program must provide his own verification. Frequently this is as time consuming as the development of the program itself.

The first two problems are further complicated by the lack of a centralized focal point for user information. In many cases, a computer program is obtained by a District to solve a particular problem only to determine, after many man-hours of work, that the program is not appropriate.

This lack of centralized user information shows the vital need for user manuals which, in many cases, are not available. It should be emphasized that user manuals are substantially different from program documentation, which in many instances is of little use to the design engineer.

Lack of centralized maintenance is another problem which has been encountered. Many instances have occurred where a computer program could not be used; the computer was not available to the particular District for which the program was adapted.

Finally, a general lack of knowledge of what is currently available has, in some cases, caused many of the above problems.

Progress has been made by both OCE and WES in an effort to eliminate the above-mentioned problems, this conference being a prime example. Over the past 3 yr, OCE has funded Rock Island and other Districts to standardize existing programs for Corps-wide use. The Rock Island District has also been instrumental in the instruction of some 17 Districts throughout the Corps in the use of existing programs developed and used in NCD. This effort is supported by NCD and additional effort toward standardization of Corps-wide accepted and verified programs is recommended. One additional step in this process is to incorporate and reference OCE sanctioned programs into existing Engineer Manuals which govern the design of various types of structures. This, in conjunction with the establishment of a central location for user information could give the designer personal contact with a qualified user of a universally accepted program. This individual must be familiar with all aspects of the program's use and application, which

would be also documented in appropriate user manuals. These Corps-wide programs must be maintained and updated on machines which are available Corps-wide. Finally, periodic seminars within each Division and Corps-wide to disseminate available programs would provide the structural engineer with the knowledge and necessary contacts to obtain the programs which are available to solve his individual problems when it occurs.

In conclusion I will comment on three matters. The first concerns the question: Are we the Corps of Engineers or the Corps of Clerks? The structural engineer in NCD, and, I'm sure, within the Corps, is alive and well. A number of years ago there were a lot of hardware problems and we weren't really getting the computers we needed to do the job. We have made tremendous strides along this line. We have gotten time-sharing availability and graphics availability; I think the needs of the structural engineer have been championed by WES and OCE at the highest levels. This has to continue. If his needs, in these days of manpower space limitations, aren't championed: God help us, for he is the lifeblood of the Corps, and our designs will show it.

A second reflection concerns the concept that only the young engineer coming out of college uses computer analysis. My experience has been very favorable; management and supervisors are encouraging the use of computers and computer-aided design techniques for structural engineering. One point I would like to make to engineering management and supervisors: We have an expertise within the Corps of Engineers which I think is second to none. This expertise is going to be maintained through the training, but it's also going to be maintained through the design engineer at the District level doing the job--using the computer. That means we have to do a lot of these designs in-house, not all of them, but certainly the complicated ones. If we don't use the expertise that we have, it won't be long before we lose it.

My third comment is on the use of the term "computer-aided design techniques." When I first came with the Corps some 7 yr ago the term "computer design" was frequently used. This bothered me a little. Now this term has been replaced by the phrase "computer-aided design

techniques." I think it's an important change. We must stand back a little, take a look at our designs, and use our most valuable asset, a lot of horse sense, to insure that our structural designs work.

Appendix A: Abstracts of North Central Division Structural Engineering Computer Programs

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM		PROGRAM NO.
Gravity Lockwall Stab 1' Section		713-C8-F1-010

PREPARING AGENCY
Buffalo District

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM PHASE	STATUS OF PROGRAM STAGE
Elex M. Alter	October 1966	1	5

A. PURPOSE OF PROGRAM

Analysis of a gravity lockwall to determine base reactions, sliding factor and percent of base under compression.

B. PROGRAM SPECIFICATIONS

Written in Fortran IV language

C. METHODS

A coordinate system is used to define the gross concrete outlines and horizontal and vertical point loads, including the culvert and gallery areas and arms. The variables such as unit weights of materials and elevations of top of ground, top of rock, etc., are also defined. All the forces and moments of the forces acting on the wall are computed. The uplift is adjusted for the percent of base under compression and the base reactions are computed.

D. EQUIPMENT DETAILS

IBM 7044 computer and IBM 1401 for both card input and output to printer. (132 print positions per line).

E. INPUT – OUTPUT

Input - IBM 80 column card
Output - printer

F. ADDITIONAL REMARKS

Output is completely labeled including the input.
Source program and deck available.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.
Gravity Lockwall Mono Stability			713-C8-F1020
PREPARING AGENCY: Buffalo District			
AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STAGE
Elex M. Alter	April 1966 Rev. June 1967		

A. PURPOSE OF PROGRAM

Analysis of a gravity lockwall monolith to determine the base reactions, sliding factor and percent of base under compression.

B. PROGRAM SPECIFICATIONS

Written in Fortran IV

C. METHODS

A coordinate system is used to define the gross concrete outlines and the horizontal and vertical point loads. The necessary variables such as unit weights of materials, and elevations of top of ground, top of rock, water surfaces, etc., are also defined. All the forces and moments of the forces acting on the monolith are computed in two directions. The properties of the base are computed and then by the method of column analogy, the base reactions are computed.

D. EQUIPMENT DETAILS

IBM 7044 Computer

E. INPUT - OUTPUT

Input - Cards
Output - Printer

F. ADDITIONAL REMARKS

Documentation available from St. Louis District.

References: EM 1110-2-2607, 1 Jul 58 and EM 1110-2-2602, 30 June 60.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.	
Single Drydock Structure on Elastic Foundation			713-C8-F1030	
PREPARING AGENCY				
Buffalo District				
AUTHOR(S)	**DATE PROGRAM COMPLETED**	**STATUS OF PROGRAM**		
		PHASE	**STAGE**	
Elex M. Alter	August 1966			

A. PURPOSE OF PROGRAM

Analysis of a single drydock type wall (1 foot section) to determine base reaction, moments and shears for use in computing reinforcement requirements in the channel slab.

B. PROGRAM SPECIFICATIONS

Written in Fortran IV.

C. METHODS

Using the equations defining deflection, slope, moment, and shear derived from the equation curve as shown in Hetenyi's book "Beams on Elastic Foundation" four equations are written defining the moments and shears at the two points of discontinuity - the faces of the left and right walls at the center of slab. The coefficients of these four equations form a (4,4) matrix. The invert of this matrix is computed using a modified version of the Gauss-Jordan method. This invert first evaluated is under no load conditions. Using unit loads for the five cases of loadings, the constant terms for each case of unit load is evaluated. These then form a (4,5) matrix. The constants of integration are computed by premultiplying this matrix by the invert forming another (4,5) matrix. The coefficients of the constants of integration in the original equations for reaction, moment, and shear, are each setup as (2 to N-1,4) matrix. This matrix is post multiplied by the constant of integration matrix (4,5). This is outputed in a (N,5) matrix forming moments, reactions, and shears, all due to unit loads for the N points along the beam. The final reactions, moments and shears at all points along the beam. The final reactions, moments and shears at all points along the beam are computed by multiplying the matrix due to unit loads times the matrix formed from the actual loads (5,NC), see Plate I for sketch and Appendix I for some typical formula.

D. EQUIPMENT DETAILS

CDC 6400 Batch

E. INPUT - OUTPUT

Input - cards
Output - Printer

F. ADDITIONAL REMARKS

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.
Beam Analysis - Combined Bending			713-C8-F1040
PREPARING AGENCY			
Buffalo District			
AUTHOR(S)	**DATE PROGRAM COMPLETED**	**STATUS OF PROGRAM** PHASE	STAGE
Elex M. Alter	October 1966		

A. PURPOSE OF PROGRAM

Analysis of a concrete beam to determine tensile and/or compressive reinforcement required. It also computes all stresses in the beam together with the allowable based on EM 1110-1-2101 and ACI 318-63.

B. PROGRAM SPECIFICATIONS

Written in Fortran IV language.

C. METHODS

Given the shear, moment and/or axial force, the physical properties of the beam and the allowable f_s and f_c the initial area of steel required determined using an initial value of kd for balanced design. A new value of kd is computed and area of steel recomputed until the final value of kd equals the value used.

D. EQUIPMENT DETAILS

CDC 6400 computer.

E. INPUT - OUTPUT

Input - IBM 80 column card
Output - Printer

F. ADDITIONAL REMARKS

Output is fully labeled.
Writeup available.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM	PROGRAM NO.
Cellular Sheet Pile Structure	713-C8-F1050

PREPARING AGENCY
Buffalo District

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM — PHASE	STATUS OF PROGRAM — STAGE
Elex M. Alter	November 1966 Rev. June 1969		

A. PURPOSE OF PROGRAM

Design of a sheet pile cell or a parallel wall by Cumming's method to determine an equivalent width with a tilting factor of safety greater than 1.5 or analysis to determine the factor with a given equivalent width. The overturning moments may be computed using active earth, hydrostatic differential and/or wave forces and/or an additional input force.

B. PROGRAM SPECIFICATIONS

Written in Fortran IV language.

C. METHODS

The program either uses an input equivalent width or computes an initial equivalent width. All overturning moments computed in program are added accumulatively and become the sum of overturning moments. The overturning moment due to active pressures of material outside of cell is computed when these materials are present. If a differential hydrostatic pressure exists, the moment due to differential water head is computed. The overturning moment due to wave pressures are computed if wave forces are present. Additional horizontal force and elevation are entered

(Continued)

D. EQUIPMENT DETAILS

CDC 6400 Batch

E. INPUT – OUTPUT

Input – Cards
Output – Printer

F. ADDITIONAL REMARKS

if there are any. If the dredge line elevation is not equal to the elevation of the bottom of cell, the following is computed: the resisting moment due to passive pressures of material outside of cell between the dredge line and bottom of cell and the frictional resistance force that can be developed. If this is a cell and not a parallel wall the total active forces due to the material in the cell from the top to the dredge line are then determined for use in computing the resisting moment due to interlock friction. The force at the dredge line is used to compute the maximum allowable radius of cell. Using Cumming's method of analysis, the resisting moment against tilting is next computed. The tilting factor of safety is then computed and for design the equivalent width of cell is increased and the above computations repeated if the tilting factor of safety is less than 1.5. After the tilting factor of safety is equal or greater than 1.5 or for analysis the sliding factor of safety and the maximum base pressure at the dredge line evaluation are computed.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.
Cantilever Pile Multi-lever Design W/WO/Impact or Wave Force			713-C8-F1060
PREPARING AGENCY			
Buffalo District			
AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STATUS OF PROGRAM: STAGE
Elex M. Alter	December 1967		

A. PURPOSE OF PROGRAM

Design of a cantilever pile wall to determine depth of embedment and the maximum moment required with one or more layers of soil on both sides of wall.

B. PROGRAM SPECIFICATIONS

Written in Fortran IV language.

C. METHODS

The number of layers and properties of each layer are defined for both sides including water head. The impact or wave forces are included if present. The point of zero shear and the maximum moment are then computed. The penetration elevation is assured and the moments computed at this elevation. This is iterated until the moment computed is zero.

D. EQUIPMENT DETAILS

CDC 6400

E. INPUT – OUTPUT

Input - IBM 80 column card
Output - High speed printer

F. ADDITIONAL REMARKS

References: "Substructure Analysis and Design" by Paul Anderson and EM 1110-2-2906 dtd. July '58 "Design of Pile Structure and Foundations" This modification supersedes previous Program No. 13 J8 F106. Program printout, deck and operating instructions available.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.	
Sheet Pile Multi-Layer Design W/Tieback			713-C8-F1070	
PREPARING AGENCY				
Buffalo District				
AUTHOR(S)	DATE PROGRAM COMPLETED		STATUS OF PROGRAM	
			PHASE	STAGE
Elex M. Alter	December 1967			

A. PURPOSE OF PROGRAM

Design of a sheet pile wall to determine depth of embedment, the tieback force and maximum moment required with one or more layers of soil on both sides of wall.

B. PROGRAM SPECIFICATIONS

Written in Fortran IV language.

C. METHODS

The number of layers and properties of each layer are defined for both sides including water head. The penetration elevation is computed as the point at which the moment about the tieback elevation is zero. The tieback force is then computed as the unbalanced shear. The point of zero shear and the maximum moment are then computed.

D. EQUIPMENT DETAILS

CDC 6400 Batch

E. INPUT – OUTPUT

Input - Card
Output - Printer

F. ADDITIONAL REMARKS

This modification supersedes previous Program No. 13 J8 F107.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.
Lock Wall Analysis			713-F5-F2013
PREPARING AGENCY			
Chicago District			
AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM	
		PHASE	STAGE
J. P. D'Aniello LT W. J. Hawes, CE			

A. PURPOSE OF PROGRAM

To analyze the stability of a lock wall by determining the vertical and horizontal reactions and safety factors against sliding and overturning.

B. PROGRAM SPECIFICATIONS

Program is written in Fortran IV.
The analysis is performed according to the following references:

a. EM 1110-2-2502 Retaining Walls
b. EM 1110-2-2602 Planning & Design of Navigation Lock Wall and Appurtenances.

C. METHODS

The summation of all forces and moments acting on the structure, including reaction forces is performed. Equilibrium equations are applied to determine, to magnitude, and location of the reactions.

D. EQUIPMENT DETAILS

GE 425

E. INPUT - OUTPUT

Input - Card
Output - Printer

F. ADDITIONAL REMARKS

A detailed writeup is available with input - output details, assumptions of analysis and limitations.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.
Structural Engineering Plane Stress - Finite Element Analysis			713-F5-F0-002
PREPARING AGENCY: Chicago District			
AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STAGE
E. L. Wilson - Univ. of CA (Berkeley)			

A. PURPOSE OF PROGRAM

To determine the stress distribution, and deflections of a two dimensional continuous body subjected to both external and body forces.

B. PROGRAM SPECIFICATIONS

Written in Fortran IV language.

C. METHODS

The solution is obtained by breaking up the continuous body into finite quadrilateral elements which are interconnected at nodal points. These elements are given physical properties. The loads are applied to the structure by external pressure cards (external loads) and unit weights (body forces) and the stiffness method of analysis is used to obtain the stresses, and deflections.

D. EQUIPMENT DETAILS

GE 425 Batch

E. INPUT - OUTPUT

Input - Card
Output - Printer

F. ADDITIONAL REMARKS

The program was adopted for use on the GE 425 computer from the IBM 7094 Version.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.
Retaining Wall Design			P8014/741-G1-F3009
PREPARING AGENCY			
Detroit District			
AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM — PHASE	STATUS OF PROGRAM — STAGE
J. W. Bowles (Bradley Universit) D. J. Cook, ADPC	15 October 1973		Complete

A. PURPOSE OF PROGRAM

The program designs a retaining wall based on a cantilever design using Working Stress Design (WSD). The cantilever is reinforced concrete with the wall elements (stem, toe, heal, and key) sized to meet general stability and structural design criteria.

B. PROGRAM SPECIFICATIONS

The program is written in Fortran IV language.

C. METHODS

The program uses a conventional method of summing up moments at the Toe with the design procedure illustrated and discussed on PP 312, 344-351 of "Foundation Analysis and Design" by J. E. Bowles - McGraw Hill 1968. The basic program taken from Appendix D with correction to Rankines Formula.

D. EQUIPMENT DETAILS

GE 225

E. INPUT - OUTPUT

Input - Card
Output - Printer

F. ADDITIONAL REMARKS

The program solves for a wall above ground water, subject to earth loads only.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.
Newmark Numerical Method for Steel Sheet Piling			713-G1-F3010
PREPARING AGENCY			
Detroit District			
AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STATUS OF PROGRAM: STAGE
M. S. Grazioli, Jr. Civil Engineer	28 January 1965		Complete

A. PURPOSE OF PROGRAM

The program designs an anchored bulkhead by four methods; Free Earth Support, Equivalent Beam, Elastic Line (Fixed Earth) and Equal Moment.

B. PROGRAM SPECIFICATIONS

1. Ten soil stratas.
2. An efficiency factor of 1.0 or 1.5.
3. Soil pressures forces, shears, etc., are computed at increments of 0.5 feet.
4. The tie rod is located at an increment of 0.25 feet.

C. METHODS

The method is described in an article titled "Anchored Bulkhead Design" by Numerical Method in the Journal of the Soil Mechanics and Foundations Division; Proceedings of the American Society of Civil Engineers dated, February 1960. Modifications have been made to conform to the Detroit District requirements.

D. EQUIPMENT DETAILS

GE 225

E. INPUT - OUTPUT

Input - Card
Output - Printer

F. ADDITIONAL REMARKS

The program is written in Fortran II.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM				PROGRAM NO.
Continuous Steel Sheet Piling Anchor Wall				713-G1-F3020
PREPARING AGENCY: Detroit District				
AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM		
		PHASE	STAGE	
Richard R. Doebler	10 Feb 1969		Complete	

A. PURPOSE OF PROGRAM

To determine the depth of penetration and required section of a steel sheet piling anchor wall. If the point of zero moment on the front wall is given, the length of tie rod is also computed.

B. PROGRAM SPECIFICATIONS

Input data consists of the elevations of the 1) top of the anchor wall, 2) tie rod 3) ground, and 4) zero moment on front wall and the force of the tie rod and any surcharge. Soil data, for 1 to 10 layers, is entered as the elevation of the top of the stratum, angle of friction, cohesion value, and unit weight of soil.

C. METHODS

Soil pressures are computed from the following formulas:

$$P_p = W \tan^2 (45^\circ + \emptyset/2) + 2C \tan (45^\circ + \emptyset/2)$$

$$P_a = W \tan^2 (45^\circ - \emptyset/2) - 2C \tan (45^\circ - \emptyset/2)$$

Net Soil = $.5P_p - P_a$ Also, $P_p - P_a$ and $\frac{P_p - P_a}{2}$ solutions are available.

D. EQUIPMENT DETAILS

GE 225 Computer

E. INPUT - OUTPUT

Input - Card
Output - Printer

F. ADDITIONAL REMARKS

The program is written in Fortran.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.
Miscellaneous Steel Design (Anchored SSP)			713-G1-F3-030
PREPARING AGENCY			
U. S. Army Engineer District, Detroit			
AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STATUS OF PROGRAM: STAGE
M. S. Grazioli, Jr.	December 1964		Complete

A. PURPOSE OF PROGRAM

To design the Miscellaneous Steel required for an Anchored Steel Sheet Piling Wall. The program designs the Tie Rods, Wales, Machine Bolts, Spreader Plates and Splice Plates.

B. PROGRAM SPECIFICATIONS

Tie Rods 1-3 inch diameter
Wales 10-18 inch width
Machine Bolts 1/2-2 inch diameter

C. METHODS

Standard design procedures as used in the Detroit District. The allowable stress for the steel is 22,000 PSI, except the Wales which is 24,000 PSI and Machine Bolts 20,000 PSI.

D. EQUIPMENT DETAILS

GE-225, typewriter, card reader and printer.

E. INPUT-OUTPUT

Input - input data consists of one card which has the Tie Rod Pull, spacing, date, project name, Tie Rod length and number of Tie Rods per splice plate.

Output - includes the sizes of the various items, and a weight per lineal foot of wall.

F. ADDITIONAL REMARKS

The program is written in FORTRAN II, Rev. IV. The weight per linear foot of wall includes all miscellanious steel for the front and anchor walls. The only weight not included is the piling. The difference in weight for a pier of Revetment Structure, is caused by the different anchorage systems.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.
Packshaw Method of Design for SSP Backwall (8005)			*741-G1-F3-070
PREPARING AGENCY: U. S. Army Engineer District, Detroit			
AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM — PHASE	STATUS OF PROGRAM — STAGE
M. Grazioli, P. Kytasty, and L. Marchinda	12 May 1967		Complete

A. PURPOSE OF PROGRAM

To determine the length and strength of the backwall of a dual walled cofferdam. The program is usefull for design of continuous anchor wall placed at a distance closer to the bulkhead than normally required. Can also solve a cantilever SSP wall by specifying Tie Rod Force = 0 and cell width extremely wide, say 99'.

B. PROGRAM SPECIFICATIONS

Feed in soil information data cards from the highest to the lowest elevation in strata, first for the soils inside cell, then for soils outside the cell. All elevations must be to the nearest 1/2 foot. Max. of 30 soil strata can be entered. Max. length of backwall cannot exceed 50 feet, or length of front wall (bulkhead).

C. METHODS

The method of deriving resisting pressures on backwall is in accordance with paper "Packshaw on Cellular Cofferdams", Transaetions of ASCE, Vol. 110, 1945. A wedge method is used to compute these pressures using soil inside cell, and scanning the backwall from the critical wedge downward in 1/2 foot, increments. Active pressures are determined by Rankine formula using soil outside cell. With all forces determined, the point of Zero Moment, Zero Shear, Sec. Modulus and total length (with 20% added for constrainment) are computed.

D. EQUIPMENT DETAILS

GE-225 Computer.
Printer output.

E. INPUT-OUTPUT

Input - Soil data for inside and outside cell, cell width, design SF (for developed shear strength), elev. of wedge origin (M=0 on bulkhead) tie rod force and elevation, surcharges for inside and outside of cell, differential head information and working steel stress desired.

Output - Length of SSP, Pt. of Zero Shear, Max. Moment and required Sec. Modulus.

F. ADDITIONAL REMARKS

The program is written in FORTRAN.

*Abstract revised 1 Aug 75 (P. K.)

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.
Analysis of Beams by Direct Stiffness Method (X0001-BEAM)			713-F3-F4-01A

PREPARING AGENCY

U. S. Army Corps of Engineers Waterways Experiment Station, Vicksburg, MS.

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STATUS OF PROGRAM: STAGE
Bill Ashton Rock Island District	May 1975	MOD1	OP

A. PURPOSE OF PROGRAM

A computer program to analyze beams of variable cross section subjected to arbitrary loading.

B. PROGRAM SPECIFICATIONS

G-600 Fortran
Time Sharing System

C. METHODS

Program uses principal of matrix structure analysis, using the displacement method.

D. EQUIPMENT DETAILS

Honeywell G-635 computer T/S

E. INPUT-OUTPUT

Input - Data may be entered interactively or from data file.

Output - Echo of data with appropriate description - then list displacements and rotations of each nodal point. Last output provides shears and moments at the ends of each beam element.

F. ADDITIONAL REMARKS

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.
(X0002-TRUSS) Plane Pin Jointed Truss Analysis by Direct Stiffness			713-F3-F4-01B
PREPARING AGENCY: U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi			
AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM — PHASE	STATUS OF PROGRAM — STAGE
Bill Ashton	May 1975	MOD1	OP

A. PURPOSE OF PROGRAM

Analyze by direct stiffness plane pin jointed truss structures to obtain individual bar forces.

B. PROGRAM SPECIFICATIONS

Program is written in FORTRAN and operates in both fixed and floating point T/S.

C. METHODS

Solution by standard Gaussian elimination techniques for determination of individual bar forces. This program is used to: assemble total truss structure stiffness from individual bar stiffness matrices - then, related equations and terms are modified to known boundary conditions. Thus, individual bar forces are determined by matrix solution by standard Gaussian Elimination techniques of nodal point displacements.

D. EQUIPMENT DETAILS

Interactive T/S.
Honeywell G-635.

E. INPUT-OUTPUT

Input - consists of no. of nodal points and no. of members, restraint at each nodal point, and Young's Modulus for each member.

Output - consists of X and Y displacements for nodal point, and also, truss bar forces and bar stresses. Additional information is provided by program.

F. ADDITIONAL REMARKS

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM	PROGRAM NO.
Analysis of Frames by Direct Stiffness Method (X0003-FRAME)	713-F3-F4-01C

PREPARING AGENCY

U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STATUS OF PROGRAM: STAGE
Bill Ashton	May 1975	MOD1	OP

A. PURPOSE OF PROGRAM

Computer program written to analyze frames of variable cross section subjected to arbitrary loading. It uses the principle of matrix structure analysis, using the displacement method.

B. PROGRAM SPECIFICATIONS

Program is written in FORTRAN and operates in both fixed and floating point.

C. METHODS

Solution by standard Gaussian Elimination techniques for determination of individual member forces. Purpose is to analyze frames of variable cross-section subjected to arbitrary loading.

D. EQUIPMENT DETAILS

Interactive T/S.
Honeywell G-635.

E. INPUT-OUTPUT

Input - consists of no. nodal points and frame members, numbering same, inputting nodal point restraints, X & Y coordinates and displacements, and moments. Then, for members, listing nodal point nos. at each end, member area, Young's Modulus, moment of inertia, and element code.

Output - will list X & Y displacements, nodal point rotation, axial load, shear and moment on ends of each member.

F. ADDITIONAL REMARKS

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM	PROGRAM NO.
Grid Analysis by Direct Stiffness (X0004-GRID)	713-F3-F4-01D

PREPARING AGENCY

U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STATUS OF PROGRAM: STAGE
Bill Ashton	May 1975	MOD1	OP

A. PURPOSE OF PROGRAM

Purpose of program is to obtain the shears, moments, and torques corresponding to the displacements and rotations of the total structure stiffness matrix of grid structures.

B. PROGRAM SPECIFICATIONS

Program is written in FORTRAN and operates in both fixed and floating point.

C. METHODS

Modified version of Gaussian Elimination is used to find displacements and rotations of the total grid structure stiffness matrix and thus, corresponding shears, moments, and torques are obtained by substitution into the individual grid element stiffness matrices.

D. EQUIPMENT DETAILS

Interactive T/S. Honeywell G-635.

E. INPUT-OUTPUT

Input - Number grid nodal points and grid members, input restraint code, X-Y coordinates, displacement, rotation, and torque. Then, nodal numbers for member ends, member area, Young's Modulus for member, moment of inertia, shear modulus, and torsion constant.

Output - consists of the displacement, rotation, and twist for each nodal point plus the corresponding shears, moments, and torques.

F. ADDITIONAL REMARKS

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM Pin Jointed Space Truss by Direct Stiffness (X0005-STRUSS)	**PROGRAM NO.** 713-F3-F4-01E
PREPARING AGENCY U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi	

AUTHOR(S)	**DATE PROGRAM COMPLETED**	**STATUS OF PROGRAM** — **PHASE**	**STAGE**
Bill Ashton	May 1975	MODL	OP

A. PURPOSE OF PROGRAM

To provide space truss bar forces of space structures composed of members assumed straight between joints, with loads at joints only, and whose ends are free to rotate.

B. PROGRAM SPECIFICATIONS

Program is written in FORTRAN and operates in both fixed & floating point.

C. METHODS

Solution by a modified Gaussian Elimination procedure. The space truss far forces of space structures composed of members which are assumed straight between joints, with loads applied at joints only & whose ends are free to rotate, are provided by this program.

D. EQUIPMENT DETAILS

Program is written interactively in T/S. Uses Honeywell G-635.

E. INPUT-OUTPUT

Input - consists of numbering nodal points & members, providing nodal restraints - X, Y, & Z coordinates, loads, nodal end numbers, member area, and Young's Modulus for Member.

Output - provides list of X, Y, & Z displacements for space truss nodal points and, also, bar forces & stresses.

F. ADDITIONAL REMARKS

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.	
Lockwall Stability Analysis			713-G1-F4-44A	
PREPARING AGENCY: U. S. Army Engineer District - Rock Island, Illinois				
AUTHOR(S)	DATE PROGRAM COMPLETED		STATUS OF PROGRAM	
			PHASE	STAGE
Cpt. Camion W. McConnell Carl N. Johnson	Jan 1971		Complete	OP

A. PURPOSE OF PROGRAM

Stability analysis of navigation lockwalls for the loading cases given in EM 1110-2-2602.

B. PROGRAM SPECIFICATIONS

Fortran II
Fixed and floating point quantities.
Quantities in foot-kip system or any consisten system.

C. METHODS

3-dimensional analysis of lockwall monoliths. Land, intermediate, and river walls with or without gate laods.

D. EQUIPMENT DETAILS

GE 225 computer with 8K memory, on-line printer, card reader, and tape input.

E. INPUT - OUTPUT

Input - Geometric description of lockwall. Soil and water levels and properties. Loads on lockwall (Hawser, gate, others). Earthquake coefficient.

Output - Input data. Summary of all forces with their points of application. Magnitude and location of resultant for the appropriate cases analyzed.

F. ADDITIONAL REMARKS

See program write-up for limitations.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.
Analysis of Bridge Pier - AASTHO Specs (1969)			713-G1-F436A
PREPARING AGENCY U. A. Army Engineer District - Rock Island, Illinois			
AUTHOR(S) Ashton, W. D.; Logsdon, D. L.; McConnell, Capt. C. J.	DATE PROGRAM COMPLETED June 1970	STATUS OF PROGRAM — PHASE Complete	STAGE OP

A. PURPOSE OF PROGRAM

Stability analysis of highway bridge pier conforming to the group loading designated in teh 1969 AASTHE specifications for Highway Bridges. Design moments and shears, magnitude and location of resultant forces, and volume of concrete are computed

B. PROGRAM SPECIFICATIONS

Fortran II
Fixed and floating point quantities
Quantities in feet and kips (kip = 1000 lbs.)

C. METHODS

Computations of forces and moment arms from the geometric description of the pier. Stability analysis of 14 loading cases per set of data.

D. EQUIPMENT DETAILS

GE 225 computer with on-line printer, card reader and 8k memory.

E. INPUT - OUTPUT

Input - Geometric description of the pier. Appropriate loads and load factors (pressures).
Output - Load forces with locations. Volume of concrete. Summation of vertical and horizontal forces, moments in two directions, and location of resultant vertical force for 14 loading cases.

F. ADDITIONAL REMARKS

Program was written for hammer-head type pier with 2-lane roadway having 4 beams (girders). A 5th beam reaction can be added to the center of the pier.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM	PROGRAM NO.
Analysis of Telescopic Bridge Pier - AREA	713-G1-F437B

PREPARING AGENCY Department of the Army, Rock Island District Corps of Engineers, Clock Tower Building, Rock Island, Illinois 61201

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STATUS OF PROGRAM: STAGE
William D. Ashton	January 1971		

A. PURPOSE OF PROGRAM

The computer program analyzes the stability of telescopic railroad bridge piers in accordance with A.R.E.A. specifications.

B. PROGRAM SPECIFICATIONS

American Railway Engineering Association Specifications.

C. METHODS

Same as b.

D. EQUIPMENT DETAILS

Minimum requirements include 8k words, card input, and line printer output for Fortran II.

E. INPUT - OUTPUT

Input consists of description of pier geometry and loads applied through superstructure.
Output provides all forces and moments required in the stability examination.

F. ADDITIONAL REMARKS

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.
Pile Foundation Analysis by Hrennikoff's Method			713-G1-F4-62A
PREPARING AGENCY: Rock Island District Office			
AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STAGE
P. Michael Boyd	Oct. 16, 1967	3	

A. PURPOSE OF PROGRAM

Determine the individual pile loads for a group of piles including battered and vertical piles. The program computes the axial and traverse forces in each pile and the induced moments for a given loading condition.

B. PROGRAM SPECIFICATIONS

1. 'The load carried by each pile is proportional to the displacement of the pile head. The footing movements are small.
2. All piles behave alike with regard to the load-deformation relation.
3. The footing, in which the piles are embodied, is absolutely rigid.
4. The analysis is two-dimensional. The piles and external forces are arranged in planes transverse to the length of the foundaiton and they are symmetrical with respect to the transverce middle plane.

C. METHODS

Hrennikoff's method of analysis is developed and solved by the program. It is a method based on the theory of beams on an elastic foundation. The method requires a knowledge of the coefficient of horizontal subgrade reaction.

D. EQUIPMENT DETAILS

The program was written for a 200 series BE machine in Fortran II. The equipment includes 8k words, card input, line printer output for Fortran II.

E. INPUT - OUTPUT

Input - Identification of project. applied loads, number of pile groups, pile section, pile and soil properties, geometry of the pile group.

Output - The output gives the transverse and longitudinal forces resulting in the individual piles and also the induced moment. These values are given for both pinned and fixed end conditions.

F. ADDITIONAL REMARKS

References:
1. Credit should be given to Savanna District. A similar program was received from them and was used heavily as a reference to write this program.
2. Analysis.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.
Concrete Box Culvert Frame Analysis and Design			713-G1-M1-070
PREPARING AGENCY			
USAED Albuquerque New Mexico			
AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STATUS OF PROGRAM: STAGE
Jack J. Miller	September 1975	Modified	Operations

A. PURPOSE OF PROGRAM

To rapidly and conveniently analyze and design simple concrete frames, particularly box culverts or conduits under high fills. The analysis is limited to uniformly or triangularly loaded prismatic or haunched members which are not subject to significant sidesway or deflection.

B. PROGRAM SPECIFICATIONS

The program is written in FORTRAN IV for the GE 437 and the GE 635 Computers and is an integral part of the Conversationally Oriented Real Time Program - Generating System (CORPS), a Time-Sharing System.

C. METHODS

1. C of E EM 1110-2-2902, 3 Mar 1969, "Conduits, Culverts, and Pipes".
2. ACI 318-71.
3. Statically Indeterminate Structures, by Chu-Kia Wang; McGraw-Hill Book Co., Inc.; 1953.
4. Concrete Plain and Reinforced by Taylor, Thompson, and Smulski; John Wiley and Sons; Fourth Edition, May 1955.
5. Columns by Ultimate Strength Design by R. C. Reese for Concrete Reinforcing Institute, First Edition, 1967.

D. EQUIPMENT DETAILS

1. GE-437 with remote GE 225 input-output.
2. GE-635 with remote time-sharing terminal.

E. INPUT-OUTPUT

Input consists of the following: frame description integers, alphanumeric problem description, concrete compressive strength, yield strength of reinforcing steel, a test integer to provide compressive reinforcing steel, a test and data variable (UTEST), clear span of member, beam depth, beam width, haunch depth, cover over reinforcing steel and load vectors.
Output - is in tabular form with headings, frame illustration, input data, fixed end moments, distribution factors, carryover factors, distributed moments, shears, thrusts, flexure design data, anchorage lengths, and shear design data.

F. ADDITIONAL REMARKS

Complete documentation is available from the Engineer Computer Program Library Technical Services Division, WES. Earlier analysis versions of this program have been published and disseminated by USAED and IBM under the title Indeterminate Frame Analysis, dated Aug 1962. Since 1962, analysis and design versions (undocumented) have been disseminated by USAED, Albuquerque, NM only when specifically requested by other users.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.
Computer Analysis of Twin Box Culverts			713-G1-F4-38A
PREPARING AGENCY: Iowa State Highway Commission			
AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STAGE
ISHC	1959		

A. PURPOSE OF PROGRAM

Analysis of twin barrel reinforced box culverts.

B. PROGRAM SPECIFICATIONS

American Association of State Highway and Transportation officials specifications.

C. METHODS

Moment distribution

D. EQUIPMENT DETAILS

Minimum requirements include 8K words, card input, and line printer output for FORTRAN II.

E. INPUT-OUTPUT

Input is a description of geometry and loading.

Output provides required wall thickness, bar areas, and bar cut-off points.

F. ADDITIONAL REMARKS

Program has been used extensively in highway relocations of Iowa roads. (William Ashton)

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM Analysis of Moments, Shears, and Reactions for Moving Loads on Simple Spans	**PROGRAM NO.** 713-F7-F4-21A
PREPARING AGENCY Rock Island District	

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STATUS OF PROGRAM: STAGE
William D. Ashton	March 1967		OP

A. PURPOSE OF PROGRAM

To produce stresses approximating the greatest loads to be regularly expected and the heaviest load likely to cross a structure (at a reduced factor of safety) using the design specifications of AASHTO and AREA.

B. PROGRAM SPECIFICATIONS

FORTRAN TSS

C. METHODS

The influence line is used to evaluate the effect at a given section due to the moving of the wheels across the structure. For a given point the properties of the influence lines are computed. The front wheel is then placed at the point under consideration and shear, moment, and reactions are determined. The system of wheels is then moved forward until the second wheel is at the point and the effect on shear, moment and reaction is again determined. This routine is repeated until the last wheel is at the point under consideration. The maximum shears, moments, and reactions are determined in a similar manner for each point requested.

D. EQUIPMENT DETAILS

Honeywell G-437 TSS
and G-635 TSS.

E. INPUT-OUTPUT

Interactive time-sharing.

Input - consists of nine variations of load description including the completely general case. In addition the data specifying span length and analysis points is required.

Output - consists of moments, shears, and reactions for all positions of wheel load at all points requested along with a tabular listing of maximum conditions.

F. ADDITIONAL REMARKS

Documentation available from Rock Island District.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM Analysis of Non-Composite Steel Girder (GIRD1)			**PROGRAM NO.** 713-F7-F4-31A
PREPARING AGENCY Rock Island District			
AUTHOR(S) William D. Ashton Richard C. Atkinson	**DATE PROGRAM COMPLETED**	**STATUS OF PROGRAM** **PHASE**	**STAGE** OP

A. PURPOSE OF PROGRAM

This program analyzes plate girders in accordance with the 1969 AASHTO specifications.

B. PROGRAM SPECIFICATIONS

FORTRAN TSS

C. METHODS

The program provides the properties of the girder for negative moment with the appropriate section moduli and stresses. In addition, the shear stress is compared to the allowable.

D. EQUIPMENT DETAILS

Honeywell G-437 TSS and Batch
Honeywell G-635 TSS and Batch

E. INPUT-OUTPUT

TSS

F. ADDITIONAL REMARKS

Documentation available from Rock Island District.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM Analysis of Composite Steel Girder (GIRD2)	**PROGRAM NO.** 713-F7-F4-31A
PREPARING AGENCY Rock Island District	

AUTHOR(S)	**DATE PROGRAM COMPLETED**	**STATUS OF PROGRAM** PHASE	STAGE
William D. Ashton Richard C. Atkinson			OP

A. PURPOSE OF PROGRAM

This program analyzes composite plate girders for positive moment.

B. PROGRAM SPECIFICATIONS

FORTRAN TSS

C. METHODS

The analysis procedures and output format is similar to Design Example No. 2 for Composite Welded Plate Girders described in detail in U. S. Steel's "Highway Structures Design Handbook, Volume II". The program conforms to 1969 AASHTO specifications.

D. EQUIPMENT DETAILS

Honeywell G-435 TSS

E. INPUT-OUTPUT

Time-Sharing terminal

F. ADDITIONAL REMARKS

Documentation available from Rock Island District

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM	PROGRAM NO.
Cantilever Sheet Pile Wall	713-G1-F5010

PREPARING AGENCY
St. Paul District - U. S. Army Corps of Engineers

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STATUS OF PROGRAM: STAGE
W. D. Ashton, Rock Island District	June 1966		

A. PURPOSE OF PROGRAM

This program will analyze a cantilever sheet pile wall in sand which depends solely on its embedment for stability. The program is written for the full flood condition. It assumes that active and passive earth pressures are governed by Coulombs Theory. It further assumes that the net water pressures vary linearly and reach equilibrium at the theoretical end of the piling.

B. PROGRAM SPECIFICATIONS

Program is written in FORTRAN II, requires 5,100 words of memory and does not require external storage.

C. METHODS

The program computes the water and earth forces acting on the wall. Knowing all the forces and lever arms, the sum of the positive and negative moments is found. The difference is tested. The difference is positive until the theoretical end is reached at which time the sign reverses. Having determined the theoretical embedment length, the program computes the shear and moment ordinates at each 0.5 foot, starting from the top.

D. EQUIPMENT DETAILS

GE-225, 8K memory with card reader, high speed printer, 4 magnetic tapes, 1 card punch, and hardware MOVE.

E. INPUT - OUTPUT

Input - data consists of the exposed height of wall on the riverside and on the land side, the unit weight of dry soil, and the active and passive earth pressure coefficients on the riverside and on the land side.

Output - data consists of the penetration of the sheet piling below the top of the riverside ground surface, the values of bending moments and shears at half foot intervals beginning at the top of the wall, and values of horizontal earth and water loads for the earth and water pressure diagrams.

F. ADDITIONAL REMARKS

Write-ups, flow chart, operating instructions are available from the St. Paul District ADP Center.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM	PROGRAM NO.
Moment Distribution	713-G1-F5020

PREPARING AGENCY
St. Paul District - U. S. Army Corps of Engineers

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STATUS OF PROGRAM: STAGE
W. D. Ashton - Rock Island District	June 1966		

A. PURPOSE OF PROGRAM

This program will distribute fixed-end moments for continuous beams without haunches and with less than 10 spans. The program will solve for both pinned and fixed-end conditions.

B. PROGRAM SPECIFICATIONS

Program language: FORTRAN II. No external storage required.
Requires 3,668 words of storage.

C. METHODS

Distribution of fixed-end moments is accomplished by methods discussed in "Continuous Frames of Reinforced Concrete", by Cross and Morgan.

D. EQUIPMENT DETAILS

BE-225, 8K memory with card reader, high speed printer, 4 magnetic tapes, 1 card punch, and hardware MOVE.

E. INPUT - OUTPUT

Input - data consists of the distribution factor at the left and right reactions, carry-over factor at the left and right ends, span lengths, moments of inertia and the fixed-end moments.
Output - data consists of a list of input data and the final moments after distribution.

F. ADDITIONAL REMARKS

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.
Concrete General Flexure Analysis			713-G1-F5030
PREPARING AGENCY St. Paul District - U. S. Army Corps of Engineers			
AUTHOR(S) Seattle District - U. S. Army Corps of Engineers	DATE PROGRAM COMPLETED October 1967	STATUS OF PROGRAM PHASE	STAGE

A. PURPOSE OF PROGRAM

This program will analyze any shaped concrete or reinforced concrete section subjected to an axial load with symmetrical or unsymmetrical bending and it will determine the location of the neutral axis of the transformed section and the stresses throughout the section.

B. PROGRAM SPECIFICATIONS

Program language: FORTRAN II. No external storage required.
Requires 6,448 words of storage.

C. METHODS

Computation is accordance with Article 1.7.8(F) and INT.2(62), Article 1.7.8(F), "Concrete Design, Columns, Conbined Axial and Bending Stress", "Standard Specifications for Highway Bridges AASHP, 1965", and "Analyzing Non-Homogeneous Sections Subjected to Bending and Direct Stress", William G. S. Saville, in Civil Engineering, March 1940.

D. EQUIPMENT DETAILS

GE-225, 8K memory with card reader, high speed printer, 4 magnetic tapes, 1 card punch, and hardware MOVE.

E. INPUT – OUTPUT

Input - The concrete section is defined by coordinates, the reinforcement is defined by coordinates of the center of the bar and its area, and rows of reinforcement bars of uniform size may be defined by the coordinates of the end bars, the number of bars in the row and the area of one bar.

Output - The program gives the equation of the neutral axis, the stress at each point on the concrete section defined by the set of coordinates and the stress in each single bar or for the end bars in rows.

F. ADDITIONAL REMARKS

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.
T-Type Retaining Wall			713-G1-F5040
PREPARING AGENCY			
St. Paul District - U. S. Army Corps of Engineers			
AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM	
		PHASE	STAGE
S. A. Williams Rev. by: Gerald L. Cohen	June 1972	MOD1	OP

A. PURPOSE OF PROGRAM

This program obtains an optimum section of a T-type retaining wall as required for overturning stability for a given loading condition and determines the base pressure, moments and shears for use in designing the wall components.

B. PROGRAM SPECIFICATIONS

FORTRAN II.

C. METHODS

The modifications consist of the computation of the moments and shears needed to design the wall components, a reforming of the output to position the output on an 8" by 10½" page, and the capability to handle the creep theories.

D. EQUIPMENT DETAILS

GE-225, 8k with card reader, high speed printer and 2 magnetic tapes.

E. INPUT - OUTPUT

Input - CARD

Output - Printer

F. ADDITIONAL REMARKS

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.
Symmetrical U-Structure on an Elastic Foundation			713-G1-F5050
PREPARING AGENCY			
St. Paul District, U. S. Army Corps of Engineers			
AUTHOR(S) R. L. Renner W. M. Rankin - Omaha Rev. by: see Section F below	DATE PROGRAM COMPLETED January 1970	STATUS OF PROGRAM PHASE	STAGE

A. PURPOSE OF PROGRAM

The program will analyze a symmetrical U-shaped concrete structure loaded symmetrically and supported on an elastic foundation. The shears, moments, deflections and soil pressures required to design the structure are computed by this program.

B. PROGRAM SPECIFICATIONS

Program is written in FORTRAN II, no external storage is required. This program is limited to analyze a given section. If soil pressure or concrete stresses exceed allowable values, new trial dimensions must be chosen and another computer run msut be made.

C. METHODS

The cantilever walls and floor slab are designed to act together as a monolith so that the loads on the walls convined with the loads on the floor slab produce a unique distribution of foundation reactions or pressures. In the analysis of the floor slab, the assumptions are made that the foundation pressures are distributed in accordance with the theory of beams on elastic foundation. The theory was extensively developed by M. Hetenyi in his book, "Beams on Elastic Foundation", from which the solutions of differential equations were taken to derive the equations used in the analysis.

D. EQUIPMENT DETAILS

GE-225, 8k memory with card reader, high speed printer, 4 magnetic tapes, 1 card punch, and hardware MOVE.

E. INPUT - OUTPUT

Input - The program requires input data specifiying the geometry of the structure, the soil and water loading conditions, foundation modulus, and the modulus of elasticity of concrete.

Output - consists of the shears, moments, deflections and foundation pressures required to design the U-structure.

F. ADDITIONAL REMARKS

Original program revised in St. Paul District by: E. Kinnunen, M. Downs, and G. Cohen.

Write-up, flow chart and operating instructions are available from the St. Paul District ADP Center.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM		PROGRAM NO.
T-Type Flood Wall		713-G1-F5060

PREPARING AGENCY
St. Paul District - U. S. Army Corps of Engineers

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STATUS OF PROGRAM: STAGE
S. A. Williams - St. Louis District Rev. by: See Section F below	January 1970		

A. PURPOSE OF PROGRAM

This program obtains an optimum section of a T-type flood wall as required for over-turning stability and determines the base pressure moments and shears for use in designing the wall components.

B. PROGRAM SPECIFICATIONS

Program Language: FORTRAN II.
Requires no external storage.
Requries 6,500 words of memory.

C. METHODS

The method of analyzing the over-turning stability of the flood wall is based on design criteria specified in EM 110-2-2501. Uplift forces are determined by creep theory on the assumption that the creep path begins at the bottom of the riverside face of the key. The distribution of passive resistance is assumed to be as shown on Figure (b) of the EM for one condition and according to paragraph S-21 A(1) of the Engineering Manual.

D. EQUIPMENT DETAILS

GE-225, 8K memory with card reader, high speed printer, 4 magnetic tapes, 1 card punch, and hardware MOVE.

E. INPUT - OUTPUT

Input - The program requires input data specifying the geometry of the structure, soil weight, and water loading conditions.

Output - The output from this program provides the bending moment and shears necessary to design the flood wall.

F. ADDITIONAL REMARKS

Original program revised in St. Paul District by: M. B. Downs and G. Cohen.

Write-up, flow chart, and operating instructions are available from the St. Paul District ADP Center.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM
Rectangular Concrete Gate Wall Design

PROGRAM NO.
713-G1-F5070

PREPARING AGENCY
St. Paul District - U. S. Army Corps of Engineers

AUTHOR(S)
R. L. Lapp
Kansas City District

DATE PROGRAM COMPLETED
June 1962

STATUS OF PROGRAM
PHASE
STAGE

A. PURPOSE OF PROGRAM

The purpose of this program is, by a structural analysis, to define the required thickness of concrete and amount of steel reinforcement at any location in the structure.

B. PROGRAM SPECIFICATIONS

Program language: FORTRAN II.
No external storage is required.
Requires 5,300 words of memory.

C. METHODS

The concrete and steel design conforms to the provisions of the ACI building code (ACI 318-56). Using the ACI code and the straight-line theory of design for working stresses, the concrete is determined to resist compression and diagonal tension without special reinforcement and the steel is selected to resist tension and change in tension (bond stress).

D. EQUIPMENT DETAILS

GE-225, 8K memory with card reader, high speed printer, 4 magnetic tapes, 1 card punch, and hardware MOVE.

E. INPUT-OUTPUT

Input - The input data for the structural analysis pertains to the properties of the concrete, steel and earthfill, the geometry of the structure, and certain design considerations.

Output - The output data defines the required thickness of concrete and amount of steel reinforcement (bar size and spacing) at any location in the structure. The total steel and concrete requirements are also given.

F. ADDITIONAL REMARKS

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM	PROGRAM NO.
Oblong Conduit Structure Analysis and Design	713-G1-F5-080

PREPARING AGENCY

St. Paul District

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STATUS OF PROGRAM: STAGE
Marion Harter James L. Goering	July 1970		

A. PURPOSE OF PROGRAM

This program performs a completely automatic structural design or review of an oblong or circular conduit.

B. PROGRAM SPECIFICATIONS

FORTRAN II

C. METHODS

The program uses structural analysis to define the required thickness of concrete and the amount of steel reinforcement at any location in the oblong conduit for design purposes ro review the stresses in the steel and concrete for a given loading condition.

D. EQUIPMENT DETAILS

GE-225, 8K system including card reader, card punch, high speed printer and 4 magnetic tapes.

E. INPUT-OUTPUT

F. ADDITIONAL REMARKS

Originally written by Kansas City District. Their reference file number is 713-F5-C1-01B. (13-R3-C122).

The program has been modified in the St. Paul District by M. B. Downs and G. L. Cohen to run on the GE-225 computer system.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.	
Cantilever Sheet Pile Drop Structure, Cohesionless Soil			713-G1-F5090	
PREPARING AGENCY St. Paul District, U. S. Army Corps of Engineers				
AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM		
		PHASE	STAGE	
Marlin A. Munter	December 1968			

A. PURPOSE OF PROGRAM

This program will analyze a cantilever sheet pile drop structure which depends solely on its embedment in cohesionless soil for stability.

B. PROGRAM SPECIFICATIONS

Program language: FORTRAN II.
No external storage is required.
Program requires 3,700 words of memory.

C. METHODS

Starting at the upstream face of the piling, the program assumes full hydrostatic pressure down to the level of the downstream channel bottom. Then the water pressure varies linearly and reaches equilibrium at the theoretical end of the piling. For treatment of soil pressure distribution, see "Substructure Analysis and Design", by Andersen.

D. EQUIPMENT DETAILS

GE-225, 8K memory with card reader, high speed printer, 4 magnetic tapes, 1 card punch, and hardware MOVE.

E. INPUT-OUTPUT

Input - The required input data consists of the water loading, saturated soil weight and the active and passive pressure coefficients.

Output - The output consists of a list of the input data, the water loading by each segment, soil pressure loadings, penetration for location of zero moment, point of maximum moment and the value of the maximum moment.

F. ADDITIONAL REMARKS

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM	PROGRAM NO.
Geometry of Tunnel Transition Structures for Outlet Work	713-G1-F5100

PREPARING AGENCY

U. S. Army Engineer District, St. Paul

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STATUS OF PROGRAM: STAGE
Original: (Huntington Dist.) Messrs. Urban and Stone Rev. by: See Section F below	Original: July 1964		

A. PURPOSE OF PROGRAM

This program is designed to compute the interior geometry for the transition between a two or three sluiced intake structure and a circular outlet tunnel.

B. PROGRAM SPECIFICATIONS

Program Language: FORTRAN II

No external storage is required.

Requires 4,650 words of memory.

C. METHODS

Follows criteria in EM 1110-2-1602.

D. EQUIPMENT DETAILS

BE-225, 8K memory with card reader, high speed printer, 4 magnetic tapes, 1 card punch, and hardware MOVE.

E. INPUT-OUTPUT

Input - consists of pertinent data for geometry of sluices and conduit.

Output - consists of the resulting geometry and areas at definite increments along the structure.

F. ADDITIONAL REMARKS

Revised in St. Paul District by G. L. Cohen to run on GE-225.

ELECTRONIC COMPUTER PROGRAM ABSTRAC.

TITLE OF PROGRAM			PROGRAM NO.
Box Culvert Design - One Cell			713-G1-F5110

PREPARING AGENCY

St. Paul District, U. S. Army Corps of Engineers

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STATUS OF PROGRAM: STAGE
W. T. Miller (Vicksburg District) Rev. by: See Section F below	February 1973		

A. PURPOSE OF PROGRAM

The problem is to determine the minimum thicknesses of the horizontal and vertical members and the area of reinforcing steel to provide for moment and the required factor of safety for cracking load for shear. For a given loading condition, the program will find the minimum thicknesses required to support the load or it will compute the resulting stresses, d's, steel reinforcing and factor of safety in members of known thickness. The program does not compute for haunches. Backfill is considered to be level over the completed structure.

B. PROGRAM SPECIFICATIONS

Program language: FORTRAN II. No external storage required.

C. METHODS

The design is in accordance with the criteria set forth in EM 110-2-2902. Safety factors for cracking shear load are computed by the method set forth in "Development of Design Criteria for Reinforced Box Culverts, Part II: Recommendation fór Design," by De Cossio and Siess.

D. EQUIPMENT DETAILS

GE-225, with 8K memory, card reader, card punch, high speed printer, and two magnetic tapes.

E. INPUT-OUTPUT

Input - The input data for the structural analysis pertains to the properties of the concrete, steel and earth backfill.

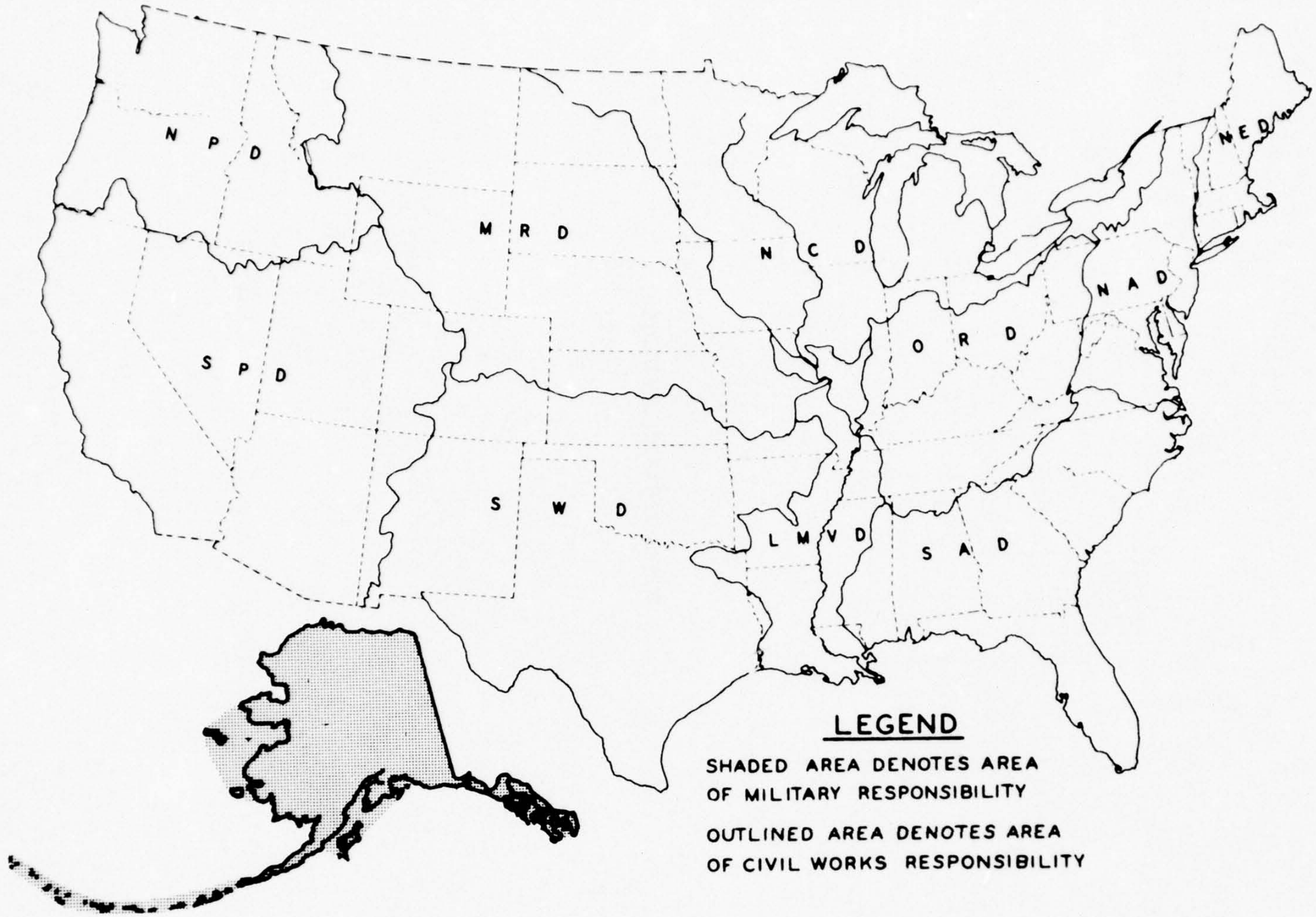
Output - The output data defines the required thickness of concrete and amount of steel reinforcement at any location in the structure.

F. ADDITIONAL REMARKS

Revised in the St. Paul District by Terry Johnson and Gerald Cohen so the user may choose the concrete cover for the culvert.

The Vicksburg District Program number is 13-G1-A406.

NORTH PACIFIC DIVISION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LEGEND
SHADED AREA DENOTES AREA OF MILITARY RESPONSIBILITY
OUTLINED AREA DENOTES AREA OF CIVIL WORKS RESPONSIBILITY

NORTH PACIFIC DIVISION

by

David Ross*

Equipment

Figure 1 shows the type and distribution of our equipment. The central processing unit and extended core memory have a total memory of 1.5×10^6 bytes. District computers, generally, do not solve engineering problems because they are used primarily as high speed terminals to receive and transmit work to the central processing unit.

Input-Output

Input-output may be described as follows:

a. Input from users is either batch mode, thru a card reader, and TSO (time share option) or interactive thru TSO using "speakeasy."

b. Output is furnished to user in 3 forms: (1) printed, either by high speed printers (600 lines per minute) or thru remote terminals; (2) graphical, either TSO on a CRT screen (tektronics) or a flat bed plotter (calcomp), and (3) microfiche.

Existing Programs

The attached listing, Appendix A, covers our current library of programs used within the Division for the last 3 yr. Abstracts are furnished for those programs frequently used (50 times or more). Available on call are abstracts for infrequently used programs. Unused programs are placed on inactive status and have not been included in the listing.

ICES STRUDL is the most frequently used program, 50% of the total

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* Structural Engineer, North Pacific Division (NPD).

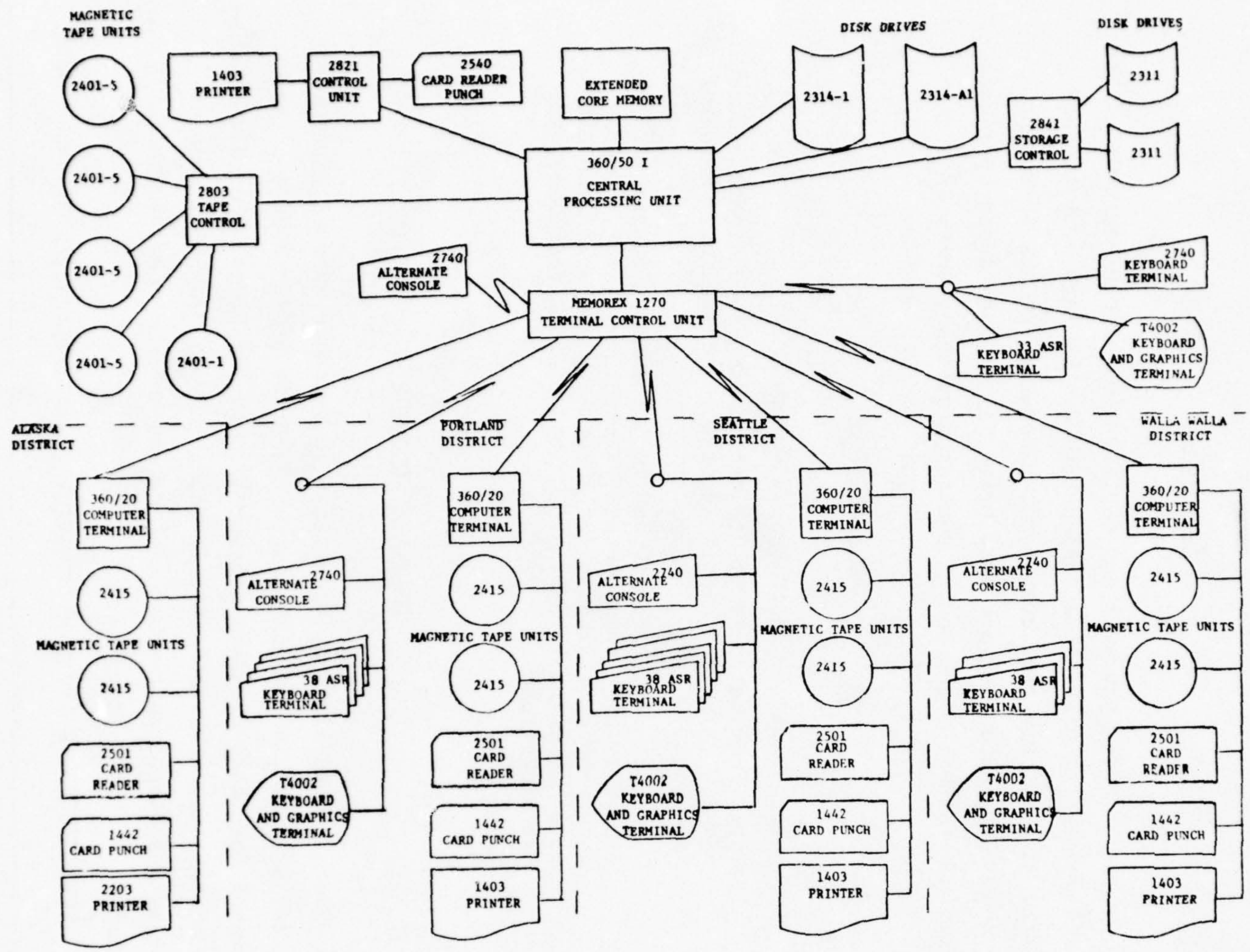


Figure 1. Type and distribution of computer equipment

CPU time for structural engineering applications. GENSAP was added to our library this year and is now operational. Instruction on its capability and uses is scheduled to inform the users. ICES STRUDL and GENSAP make a powerful package for solving all types of problems. At this time, we can't project the frequency of use for GENSAP. A few years will establish a track record.

In addition to GENSAP we have added to the system "speakeasy"--a user oriented language. The language is designed to help the engineers to quickly formulate a problem for machine processing and get answers to their problems in a minimum of time. Ease of use, familiar notation, and built-in capabilities for expansion are the main features of language. We expect to instruct the users in the capabilities of "speakeasy."

New Programs

There has been no activity and none is anticipated in the writing of complex structural programs (e.g. frame solvers) in this Division. However, simple programs (e.g. composite section) and maybe a few moderate programs (e.g. matrix solvers) will be written in the future. We believe our existing library and outside program sources are sufficient to solve any future structural problem. For those programs that we may write, the program's complexity generally determines the course of action. Normally, a new program is justified by future uses, approved for development at the section and branch level, and is written by either a structural engineer or ADP personnel or both. The cost of development is usually charged to the project and job for which the program will be used. We do not know whether any program development has been done with R&D funds.

Informing User on Programs

The users are informed thru our NPD newsletter (infrequently published), user contact with local ADP personnel, and word of mouth

between fellow engineers in and out of the Corps. If an engineer has a particular problem and we don't have an applicable program, ADP makes the necessary search thru the other agencies. In the past, if no program was available, and the problem could justify a special program, one was developed. As mentioned earlier, no new complex problem solvers are necessary.

Computer Budget and Staff

NPD's 1975 budget for central processing unit including accessories and staff (24 people) is approximately $1.3 million. Total Division costs including Districts' equipment and personnel will be approximately $2.4 million. NPD's entire ADP staff is 86.

Computer Output

There are two classifications of computer output, engineering, including math and science, and personnel-fiscal. Our yearly average production work is approximately 2300 CPU hr or 155,000 programs processed. Engineering's portion, which includes each branch, is approximately 50% of the total CPU time or 38,000 programs. Structural engineering's share is approximately 3% of the total engineering production. There are several reasons for such a small percentage: the engineer can do his work more quickly in longhand than he can obtain results from the machine; the potential user is not adequately trained in using programs in the library; the work load involving complex design has tapered off or is between design stages.

User Profile

Since structural use of the computer is so small, we prepared a brief questionnaire for our structural engineers in an attempt to learn how they use the computer in their work. Several categories were considered: (a) general and computer education, (b) structural design

experience and percentage of design using machine, (c) criteria for using or not using computer, and (d) suggestions for improving the engineer's efficiency and productive effort by beneficial use of the computer. The results provided a useful profile of the user and what areas need to be modified to decrease repetitious, routine work in design.

<u>General and computer education</u>

a. Generally there are 62 structural engineers including the chiefs and their assistants in structural design sections. The average age of the engineer is 43 (youngest 28, and oldest 62); all have B.S. degrees and 6 have M.S. degrees; and 90% have had various amounts of advanced work.

b. The average amount of computer schooling (not programming) is 3 weeks; engineers (28-35) 1 to 2 terms; engineers (36-45) 4 weeks Corps schooling and self-development; engineers (49-62) 1 week Corps schooling. Only 1/3 of the users said they had written programs and only 1/2 of those in the last 3 yr. The type of programs written were simple (composite section) and moderate (matrix solvers)--the developments were charged to the job and 5% of these were documented.

<u>Structural design experience and percentage of design using machine</u>

Average design experience is 14 yr (minimum 1 yr and maximum 28 yr). The division of the engineers design work is approximately 30% steel, 45% concrete, 10% prestressed concrete, and 15% block, wood, and other. The percentage of design by the computer is difficult to estimate because of the many variables; an average percentage is in the range of 10 to 20%.

<u>Criteria applied by engineers on using a calculator or computer</u>

a. Amount of time required for a structural design, either in parts or whole, using a calculator or a computer including selecting programs, preparation of input, turnaround time, working out bugs, etc.

b. Whether the job is repetitious; such as compiling quantities, rebar takeoff, etc. Also, will the problem require several runs to optimize the design.

c. Amount of time and effort required to become familiar and confident with the new programs. How much effort is required to relearn input and output of existing programs not frequently used.

d. Evaluation of previous difficulties with input, computer service, output, and whether there is an overabundance of unnecessary information from a program's output.

User problems encountered with existing and new programs

a. General programs are difficult to understand and require a great deal of time to prepare input initially such as ICES STRUDL.

b. User guides and manuals are neither well written nor easy to follow.

c. Input for general and specific programs is difficult on first usage and is easily forgotten if not used frequently. As a result errors creep in and make use of a program more time consuming.

d. More help is needed from ADP on keeping user informed as to new programs and an explanation of changes, program operations, etc., to existing and new programs.

Summary of modifications that can be made to increase productivity and increase use of the computer

a. Faster turnaround, almost instantaneous, small load module, interactively run free formatted, flexible STRUDL type loading input plane frame analysis program.

b. Write-up in user manual written so that anyone, after reading the manual, can use the program in less than 1 hr for simple and moderate programs and in just a few hours for complex programs.

c. Take emphasis off the "giant" general finite element programs and concentrate on maximizing user proficiency on production jobs, small frames, etc.

d. Strengthened support from ADP to handle engineering programming such as a "hotshot" Civil Engineers (systems function and programming to assist engineers in each branch and section); specifically, in Structures have one man duly assigned to keep up with current programs and necessary background to help others.

e. Because of additional work and problems that will be encountered the users in our Division are clamoring for programmable calculators or mini-computers in their office to do production work instead of using bigger and fancier programs. Perhaps a system of small desk computers capable of solving simple production type design and tied into the central processing unit for large programs exceeding

desk-computer capacity should be considered. The desk computer is interfaced to the central unit using interactive processing. The user would remain familiar with language and programs.

f. Implementation of computer graphics within Division will improve the engineer's program understanding, and give him a visual advantage on seeing and checking his input for validity and errors. Also, output will be easier to check and can verify the engineer's feeling as to correctness of the program answers. With the capability for interactive access, processing, and visual display, a major step will be taken to increase productivity.

Appendix A: List of Minimum Use Programs, Abstracts Available

713-K5-G0040	Reinforced Concrete Wall Design
713-K5-G0070	T-Frame Analysis for Libby Dam
713-K5-G0080	Bridge Rating and Analysis System
713-K5-G0700	California Plane Stress
713-K5-G1130	Transmission Line Sag Tension Calculation
713-K5-G204A	Truss, Frame, and Beam Element Analysis
713-K5-G2110	Stress Analysis of Symmetrical Bifurcation
713-K5-G2100	Geometry of Symmetrical Bifurcation
713-K5-G2130	Grid Analysis
713-K5-G2150	Long Span Composite Pre-Stressed Beam Analysis
713-K5-G2160	Beam Column Analysis with Printer Plot
713-K5-G2170	Structural Analysis of Continuous Beams Under Hydraulic Load
713-K5-G2180	Lateral Force Distribution for Shear Walls
713-K5-G3020	Continuous Bridge Analysis
713-K5-G3210	Conduit Analysis - Elastic Center
713-K5-G3240	Pre-Stressed Girder Analysis
713-K5-G3250	Pre-Stressed Girder Tendon Design or Review
713-K5-G3290	Analysis and Girder of Simple Span Pre CST - Pre Stress Highway/Railway Bridges
713-K5-G4130	Finite Difference Analysis of Beam - Column on Elastic Foundation
713-K5-G4300	Cantilever Retaining Wall Design
713-K5-G4400	Two Dimensional Stability Analysis

For additional information or explanation on listing, call

Richard Adams, NPDDP-P 503-221-3726

Appendix B: Program Abstracts for Active Use Programs

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM	PROGRAM NO.
General Elastic and Nonlinear Structural Analysis Program	713-K5-70-06F

PREPARING AGENCY
U.S. Army Engineer Division, North Pacific

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STATUS OF PROGRAM: STAGE
U.S. Army Engineer Division, Huntsville R. H. Adams (Modification)		MOD	TEST

A. PURPOSE OF PROGRAM

This program performs static and dynamic analysis for three-dimensional structural systems. It consists of three separately Executable Codes; PRESAP, the preprocessor package, RSPNSE. The main program, and SAPOUT, the post-processor package.

B. PROGRAM SPECIFICATIONS

Batch FORTRAN IV

C. METHODS

The finite element approach of structural analysis. Mode shape extraction by either approximate Rayleigh-Ritz method or Inverse Iteration method.

D. EQUIPMENT DETAILS

IBM 360/50, 200K (32 Bit Word) Memory, Card Reader, Printer, Disc or Tape for temporary storage, Calcomp Flatbed Plotter.

E. INPUT-OUTPUT

Card Input and Printer and Plotter Output.

F. ADDITIONAL REMARKS

Report Available. "Users Guide for GENSAP Code" dated May 1972, prepared by AGBABIAN Associates for U.S. Army Engineer Division, Huntsville.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM Powerhouse Stability Analysis	PROGRAM NO. 713-K5-G0-010

PREPARING AGENCY U.S. Army Corps of Engineers, 210 Custom House, North Pacific Division, Portland, Oregon 97209

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STATUS OF PROGRAM: STAGE
R. L. Willey	June 1968	ORGIN	

A. PURPOSE OF PROGRAM

To analyze the loads acting on a powerhouse for evaluation of its stability. Program furnishes the values of all loads and their moments about the x and y axes. Loads and moments are summarized into values parallel to the axes. Loads and moments are divided into structural, applied, and earthquake. The program determines the location of the resultant at Base Plane Elevation, total values of loads parallel to the three axes and the total value of moments about the x-x and y-y axes.

B. PROGRAM SPECIFICATIONS

Program is coded in FORTRAN IV language. The following axis position is assumed: x-x axis horizontal and parallel to the longitudinal axis of the powerhouse; y-y axis horizontal and normal to x-x axis; z-z axis, vertical. Input values are restricted to certain horizontal and vertical loads imposed on a powerhouse structure, lever arms and dimensions describing various volume shapes plus earthquake data and are expressed in kips and in feet.

C. METHODS

Standard arithmetic means are used in calculating volumes, moments and loads defined by the card types containing required parameters. As each load, volume and moments are calculated these are printed and summaries are performed until all data has been processed. At this time a summary sheet is printed containing all summarized results and moments plus the location of the resultant force.

D. EQUIPMENT DETAILS

Computer: IBM System/360
Operating System: IBM System/360 Operating System
Core Requirements: (Excluding Operating System) 28K bytes
Secondary Storage: None

E. INPUT-OUTPUT

All input is from punched cards conforming to a fixed format depending on the card type. In many cases, several of a given type may be used and cards may be in any order except that the last card must be blank to initiate the summary sheet.

F. ADDITIONAL REMARKS

This program has not been documented although card input formats are available as are sample jobs. The program was conceived and written for a specific job and may not be applicable for others to use effectively.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.
Penstock Steel Liner Optimization			713-K5-G1-100
PREPARING AGENCY: Alaska District - Corps of Engineers			
AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STAGE
Marker & DeVilbiss			

A. PURPOSE OF PROGRAM

This program will determine the optimum steel type, liner thickness, quantities of steel, concrete, and excavation, and cost analysis of the same.

B. PROGRAM SPECIFICATIONS

A maximum of ten different vertical alignments may be specified, although the user is limited to a single horizontal alignment per run. For each alignment any number of steel penstock radii may be considered (incremented by three inches), as can any number of concrete thicknesses (incremented by six inches). The program can evaluate any number of different steel types and is designed to differentiate the increased unit costs of excavating smaller diameter tunnels.

C. METHODS

The governing thickness for design is the maximum of three differently calculated thicknesses: (1) the minimum thickness necessary to assure sufficient rigidity for handling based on the Bureau of Reclamation formula or 0.375 inches, whichever is larger, (2) thickness required to resist internal pressure based on the hoop stress formula, and (3) the thickness required to resist buckling due to external pressure based on the method of Amstutz.

D. EQUIPMENT DETAILS

The program is written in FORTRAN IV for an IBM System 360 Operating System Model 50. Card reader and line printer are the only devices used.

E. INPUT-OUTPUT

Input consists of geometry data, material data, cost data, hydraulic data, and plot data (not presently operational). Output provides an echo print of all input data, description data of the scheme being analyzed, the governing liner thickness, the optimum steel type, and quantity and cost take-offs.

F. ADDITIONAL REMARKS

The program originally listed as 713-K5-G110 is now accessible as 713-K5-G110A. If a fuller breakdown on pressures and thicknesses is desired for each steel type, this program should be executed using the same data deck.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM	PROGRAM NO.
Section Properties for Irregular Shapes	713-K5-G2-210

PREPARING AGENCY
U.S. Army Engineer District, Portland, Oregon

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STATUS OF PROGRAM: STAGE
1 Lt. Gene H. Unger William Wheeler	1 May 1973		

A. PURPOSE OF PROGRAM

This program takes any sectional shape and calculates the Area, Centroid, and Moment of Inertia values. The section is described by coordinated nodes, which bound it in a clockwise order around the shape. If a hole is present, it should be described by giving its boundary nodes in counter-clockwise order.

B. PROGRAM SPECIFICATIONS

The program was written in FORTRAN IV for the IBM 360/50 but will run on 360/20 with 16K bytes of storage.

C. METHODS

The necessary section properties are determined by using cartesian coordinated boundary points as the section description. The points must be listed clockwise around the section. If an internal section is to be omitted then its points must be listed counter-clockwise around the section.

D. EQUIPMENT DETAILS

The program requires a minimum of 16K bytes of storage and no special features. The program has been run using a keyboard terminal for input and output.

E. INPUT-OUTPUT This program allows the user to input the boundary points in any numbered order as long as they are in the clockwise sequence going around the section. The standard output consists of:

- Axis origin x and y
- Rotation with respect to base axis
- Area
- Inertia about x-axis
- Inertia about y-axis
- Product of inertia

F. ADDITIONAL REMARKS

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM	PROGRAM NO.
Concrete General Flexure Analysis	713-K5-G3-010

PREPARING AGENCY
Seattle District, Corps of Engineers

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STATUS OF PROGRAM: STAGE
Miller Love Ploudre Winter Gates	October 1968		

A. PURPOSE OF PROGRAM

This program will analyze any shaped concrete or reinforced concrete section subjected to an axial load with symmetrical or unsymmetrical bending and it will determine the location of the neutral axis of the transformed section and the stresses throughout the section. The program gives the equation of the neutral axis, the stress at each point on the concrete section, defined by a set of coordinates, and the stress in each single bar or for the end bars in rows.

B. PROGRAM SPECIFICATIONS

The concrete section is defined by coordinates; 100 sets of coordinates are available; curves must be approximated by short lines. The reinforcement is defined by coordinates of the center of the bar and its area. The number of loading is unlimited.

C. METHODS

The program computes the stresses in concrete cross-section by a solution of the general flexure formula. The method of solution is taken from "Analyzing Non-Homogeneous Sections Subjected to Bending and Direct Stress," William G. Saville, in Civil Engineering, March 1940.

D. EQUIPMENT DETAILS

The program is written in FORTRAN IV for an IBM System 360 Operating System Model 50. Card reader and printer are the only devices required.

E. INPUT-OUTPUT

Console and steel coordinates, material properties, and loadings are submitted as card input. A printer output listing will contain stresses at all coordinates inputted and the equation of the neutral axis of the section under the loading.

F. ADDITIONAL REMARKS

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM Ultimate Strength Design of Reinforced Concrete Columns	PROGRAM NO. 713-K5-G3-300
PREPARING AGENCY Seattle District, Corps of Engineers	

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STAGE
Portland Cement Association G. W. Ploudre (Modification)	December 1967		

A. PURPOSE OF PROGRAM

To design or investigate reinforced concrete columns by the ultimate strength theory. The program will determine the minimum amount of reinforcement and the reinforcement pattern for Round, Spiral, or Tied columns subject to an axial load combined with uniaxial or biaxial bending.

B. PROGRAM SPECIFICATIONS

Design conforms with the general requirements of the ACI Building Code (ACI 318-63). Flexible input parameters allows the engineer to set his own criteria for design.

C. METHODS Computation of ultimate strength are based on the satisfaction of the applicable conditions of equilibrium and compatibility of strains. The diagram of compressive stress distribution is assumed to be a parabola up to a stress of $.85f'_c$ at a strain ε_o and to remain uniform therefrom up to an ultimate strain ε_u. Iteration procedures are used to locate the neutral axis corresponding to the eccentrically applied compressive load. Combined biaxial bending capacities are based on a three-dimensional interaction surface whose contours for a given axial load are defined by the equation:

$$(M_x/M_{ux})n + (M_y/M_{uy})n = 1$$

D. EQUIPMENT DETAILS

This program was written in FORTRAN IV for an IBM 1130 computer and has been modified to operate on an IBM System 360 Operating System Model 50. Card reader, printer, and direct address storage device are required.

E. INPUT-OUTPUT

Varies depending on type of problem and type of column being processed.

F. ADDITIONAL REMARKS

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.
Analysis of Two-Dimensional Frame Structures			713-K5-G4-110
PREPARING AGENCY U.S. Army Engineer District, Walla Walla, Corps of Engineers, Bldg. 602, City -County Airport, Walla Walla, WA 99362			
AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STAGE
Doherty and Wilson, U. of Calif., Berkley, Modified by Grant L. Anderson	December 68		OPR

A. PURPOSE OF PROGRAM

Joint deflections, member end forces and joint reactions are determined for plane frames which may be subjected to joint loads, joint displacements and member loads.

B. PROGRAM SPECIFICATIONS

The program is written in FORTRAN IV language and requires double precision on the IBM 360 System. Program limitations are 1000 nodes. There is no limitation on number of members.

C. METHODS

The stiffness method of structural analysis is used in the program. Resulting equations are solved by a Gaussian Elimination procedure to give joint deflections.

D. EQUIPMENT DETAILS

System requirements are an IBM 360 Model 50 with card reader, on-line printer and disc storage. Program requires 152,500 bytes of core. Disc storage is used for intermediate storage.

E. INPUT-OUTPUT

Card input provides joint coordinates, member description, material properties, geometric properties, and applied loading.

F. ADDITIONAL REMARKS

Writeup available.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM	PROGRAM NO.
Finite Element Method Stress Analysis	713-K5-G4-710

PREPARING AGENCY U.S. Army Engineer District, Walla Walla, Corps of Engineers, Bldg. 602, City-County Airport, Walla Walla, WA 99362.

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STAGE
Dr. Clough & Dr. Wilson (U. of Calif., Berkley, Modified by Grant L. Anderson	29 April 68	MOD	REP

A. PURPOSE OF PROGRAM

The program provides a means of determining displacement and stresses within a plane solid with either linear or bi-linear material properties. The analysis, which is general, can be applied to any shape of structure. Loading may be any combination of node forces, displacements, or temperatures.

B. PROGRAM SPECIFICATIONS

The program is written in FORTRAN IV and requires double-precision on the IBM 360 System. Program capacity is 1700 nodes, 1700 elements and a maximum band of 45. Run time is 25 minutes for a mesh size of 1200 nodes and 1200 elements.

C. METHODS

Program uses the Finite Element technique where the structure is described by a quadrilateral mesh composed of elements which are interconnected at the nodes. From input describing nodes, elements, and material properties, the total structural stiffness is formulated. Using the stiffness and applied loads the node displacements are computed. These are then used to determine the stress in each element.

D. EQUIPMENT DETAILS

The program requires an IBM 360 Model 50 System with 2 tape units, disc storage, card reader and on-line printer. The program requires 307,000 bytes of core. Two disc files of 2,462,400 bytes each and one disc file of 116,000 bytes external storage are required.

E. INPUT-OUTPUT

Input is X and Y-coordinates of each node, nodes describing each element, and properties of each material in the structure.

Output consists of node displacements and stress at center of each element. Output stresses are X-stress, Y-stress, shear stress, principal stresses and angle of orientation.

F. ADDITIONAL REMARKS

Optional output on magnetic tape provides a plot tape which, when plotted on a Benson-Lehner Model LTE Plotter, gives quadrilateral layout, displaced structure and vector plots to aid interpretation of results.

Also, optionally provided is a magnetic tape which is used as input to a contouring program.

Writeup is available.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.	
Finite Element Analysis of Stiffened Plates			713-K5-G4-720	
PREPARING AGENCY				
University of California				
AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM		
		PHASE	STAGE	
Ian G. Buckle	July 1969	Orgin		

A. PURPOSE OF PROGRAM

The primary purpose of this program is the analysis of highway girder bridge decks of arbitrary geometry. The program may, however, be used for the analysis of general slab systems under lateral load, including slabs which are stiffened by discrete ribs.

B. PROGRAM SPECIFICATIONS

The program is written in FORTRAN IV. It requires 215k bytes of storage for execution. Input is by the card reader and output on the printer. Three sequential data sets are required for scratch data sets.

C. METHODS

Deck slab is idealized by a mesh of plate bending finite elements. The stiffness of each quadrilateral element is computed and assembled into the structure stiffness matrix. Variations of deck slab properties from element to element is permitted. The girders and diaphragms are idealized by beam finite elements joining the nodal points of the deck slab elements. Each element stiffness is individually computed and assembled into the structure stiffness matrix.

D. EQUIPMENT DETAILS

The program was written for an IBM 360/50 computer operating under OS. Magnetic tape and disk storage.

E. INPUT-OUTPUT

Input to the program is by punched card. Basically the data deck will consist of operation control cards, structure definition cards, and load case cards. Output consists of a complete printout of all input, applied loading for every load case, the displacements for all nodal points, moments of center of each plate element, the shear force, torsion moment and bending moments acting on each beam element.

F. ADDITIONAL REMARKS

for regular meshes, automatic generation is available for nodal point coordinates, nodal point arrays, support conditions, and load data. Multiple load cases can be considered without redefining the structure data for each case. Five load options are available, which include single loads, uniformly distributed loads, truck loading, and any combination of these.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM	PROGRAM NO.
General Structural Analysis Program (SAP)	713-K5-G4790

PREPARING AGENCY
University of California

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STATUS OF PROGRAM: STAGE
Edward L. Wilson	September 1970	Orgin	

A. PURPOSE OF PROGRAM

The purpose of this computer program is to perform linear, elastic analyses of three dimensional structural systems. The structural systems to be analysed may be composed of combinations of a number of structural element types. This version contains the following elements: 1) three-dimensional truss, 2) three-dimensional beam, 3) plane stress and plane strain, 4) two-dimensional axisymmetric solid, 5) three-dimensional solid, 6) plate and shell, 7) boundary.

B. PROGRAM SPECIFICATIONS

The program is machine independent and is coded in standard FORTRAN IV.

C. METHODS

Depends upon type of structural element. The method of analysis is different for each of the seven types and you almost have to read the program documentation to get a feel for the types of methods used.

D. EQUIPMENT DETAILS

Program is machine independent; the capacity of the program can be changed depending on the size of the problem to be solved and computer memory limitations. This is done by changing two FORTRAN source statements in the SAP program.

E. INPUT-OUTPUT

Input consists of control cards, joint and element descriptive data. Output depends upon type of analyses and type of structural element.

F. ADDITIONAL REMARKS

The capacity of the program depends mainly on the total number of joints in the system. There is practically no restriction on the number of elements, number of load cases, or the "bandwidth" of the equations to be solved. While the program has the capacity to analyze very large systems, there is no loss of efficiency in the solution of smaller problems as comprared to several special purpose programs presently available.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.
ICES - STRUDL - 11			802-K5-G0-800
PREPARING AGENCY: U. S. Army Engineer Division, North Pacific			
AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STAGE
M.I.T. Civil Engineering Systems Laboratory			

A. PURPOSE OF PROGRAM

This program performs static and dynamic analysis for 2-D and 3-D structural systems. It also has member selection capabilities.

B. PROGRAM SPECIFICATIONS

Batch ICETRAN (ICES, FORTRAN), FORTRAN II, FORTRAN IV, ASSEMBLER

C. METHODS

Finite Element approach to structural analysis.

D. EQUIPMENT DETAILS

IBM 360/50, 230K (32 Bit-word) memory, card reader, printer, Disc direct-access storage.

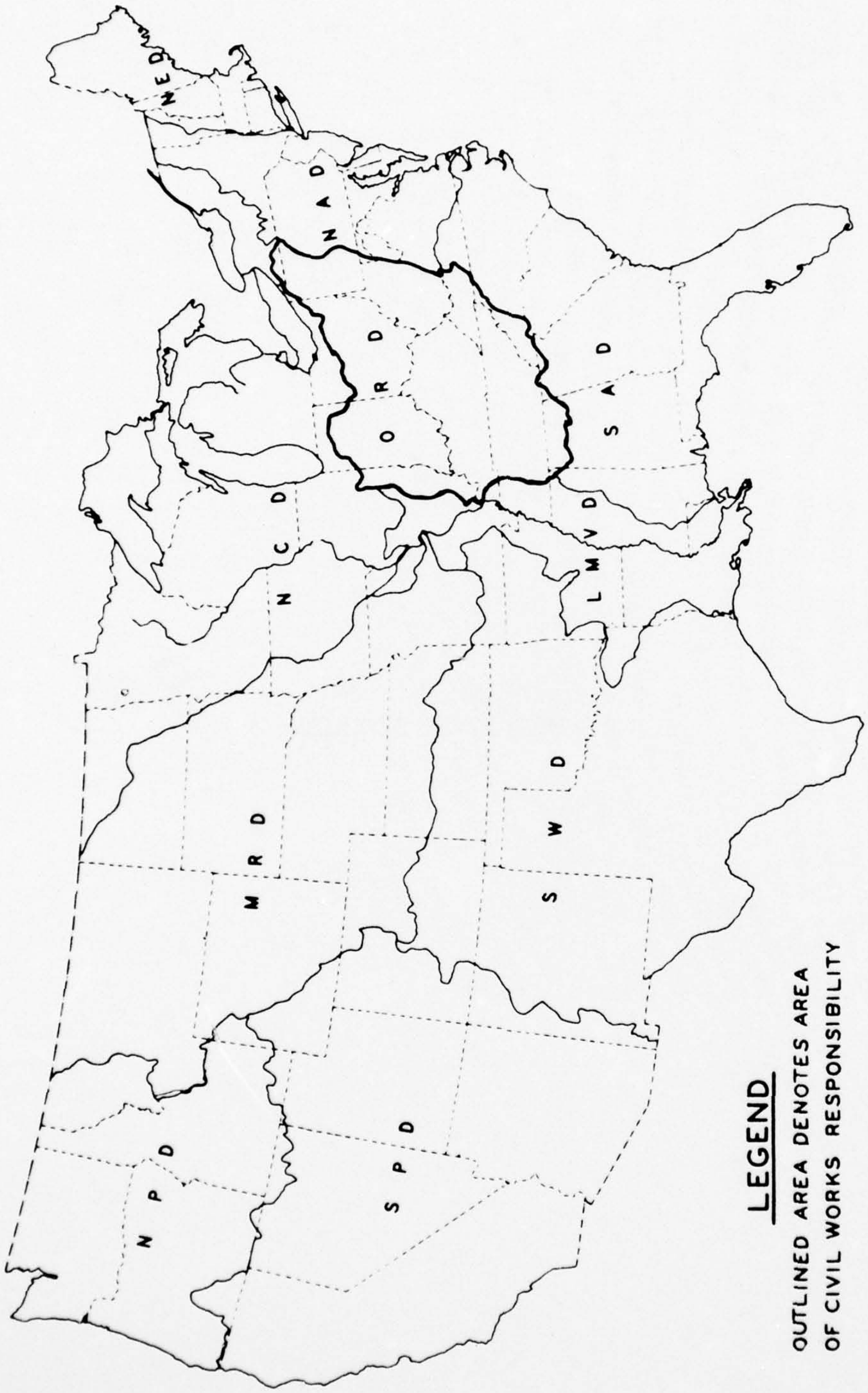
E. INPUT-OUTPUT

Card Input, Printer Output

F. ADDITIONAL REMARKS

Reports Available "ICES STRUDL - 11 Engineering User's Manual"
Vol 1 "Frame Analysis" R68-91
Vol 2 "Additional Design & Analysis Facilities R68-92
Vol 3 "Reinforced Concrete Structures" R68-93

OHIO RIVER DIVISION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OF CIVIL WORKS RESPONSIBILITY

OHIO RIVER DIVISION AND COMPUTER USE

by

Stephen F. LeMaster*

The ORD is one of ten U. S. Army Corps of Engineer Divisions throughout the country with civil works responsibilities. Our boundaries include the drainage of the Ohio River, which covers about 204,000 square miles and ranges over parts of 14 states.

With Division Headquarters in Cincinnati, we divide the area into 4 Districts with offices in Pittsburgh, Huntington, Louisville, and Nashville (Figure 1). The Division covers an important part of the

Figure 1. ORD map

United States, including areas of hard-core poverty, rich farmlands, and highly industrialized urban areas. Some 20,000,000 people live in the basin, about 11 percent of the country's population. The basin produces about 75 percent of the Nation's bituminous coal and about 25 percent of

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* Structural Engineer, Ohio River Division (ORD).

the Nation's hardwood. Approximately 1/3 of the basin is under cultivation.

Our role in civil works is water resources development; that is, the development of our waterways for all purposes, for navigation, flood control, water quality, electric power, recreation, and fish and wildlife enhancement.

Our first job in civil works was in navigation. The picture, Figure 2, was taken at the dedication of Davis Island Lock and Dam in 1885.

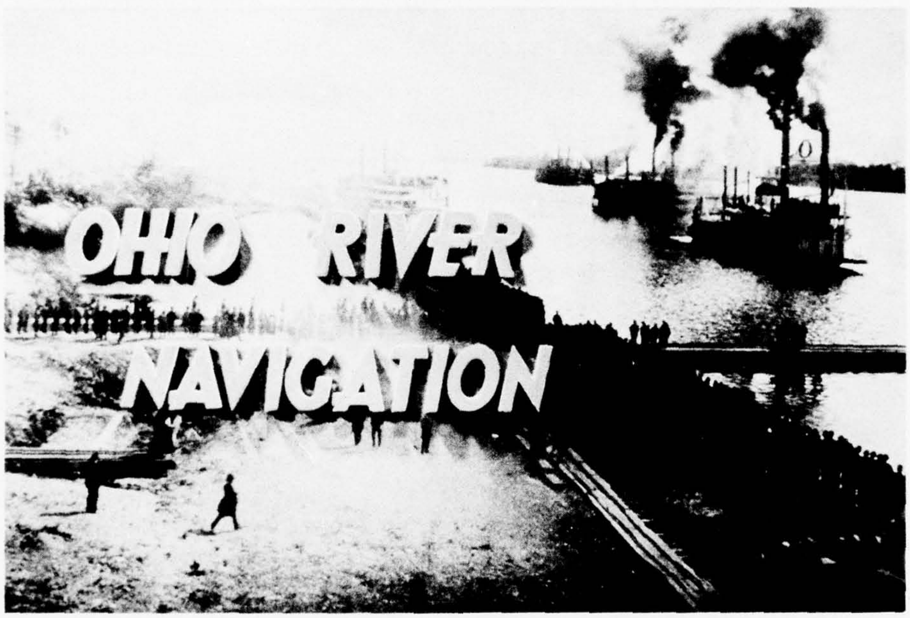

Figure 2. First Corps dam on the Ohio River, 1885

Located about five miles from Pittsburgh, this was the first of some 50 dams to be built by the Corps on the Ohio. The Corps association with the Ohio goes back to the early part of the last century when Congress, in 1824, made its first civil works appropriation--$75,000 for clearing snags from the Ohio and Mississippi Rivers.

Someone once described the Ohio River as a mile wide and a foot deep. Almost annually in late summer and fall the river would run so low that it could be waded at several places as this team of horses is doing in Figure 3.

Figure 3. Ohio River at low water

When this happened, river commerce sat on its hulls in the mud and waited for higher water. This was an obvious threat to the economic development of the basin (Figure 4).

After a number of unsuccessful attempts, the first practical solution to the navigation problems of the Ohio was the completion in 1929 of a series of 46 low-lift locks and dams similar to the one in Figure 5. The dam was built of wooden wickets, which in time of low flow could be raised to hold back a navigable channel. Each structure included a lock measuring 110 ft wide and 600 ft long. The difference in elevation between the upper and lower pools of these structures averaged about 8 ft. This system served very well during the 1930's and 40's for the steam-powered towboats of that era.

After World War II, the diesel towboat with its much greater horsepower started appearing on the Ohio. With their much greater capacities, these towboats led to situations such as the one referred to as double locking.

Double locking occurs when the tow is too long to be locked as one

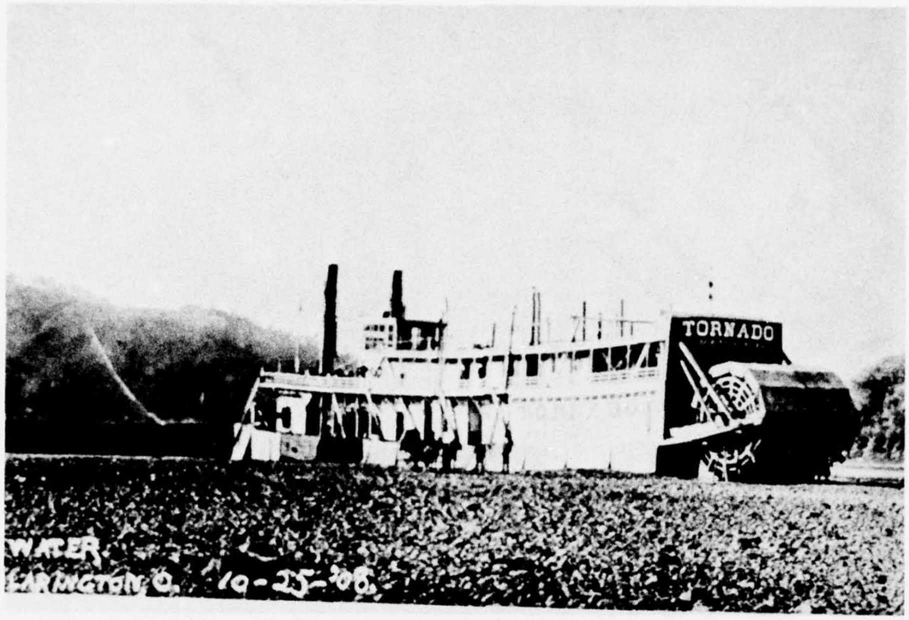

Figure 4. Towboat in river mud

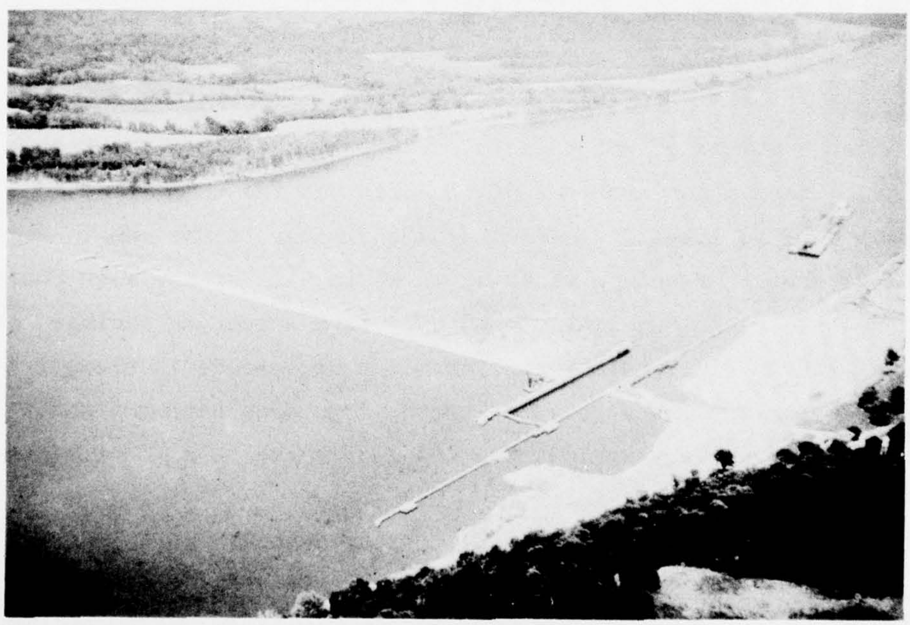

Figure 5. Low lift lock and dam, 1929

unit and must be broken into two sections to be locked through the dam. After the tow is separated, the first half is locked through and pulled out on the guide wall by a winch; then the second half is locked through and the tow rejoined. This process can take up to 2 hr and traffic jams have resulted at some of these low lift locks with tows waiting up to 2 days to lock through.

In the 1950's the Division began a modernization program to replace the 46 low lift structures with a system of 19 modern high lift dams. Markland Locks and Dam, about 60 miles downstream from Cincinnati, Ohio, is typical of the new dams. Markland has two locks, one measuring 110 by 1200 ft, which handles just about anything on the river, and a smaller lock measuring 110 by 600 ft for smaller tows and pleasure craft. Either chamber can be filled or emptied in 8 min. (The larger lock is longer than the Queen Mary and the locks on the Panama Canal, 110 by 1000 ft.) Markland, which eliminates five of the old type dams, creates a 95-mile pool. The difference between the upper and lower pools is about 35 ft.

Figure 6 shows the Ohio River Profile as it will be when all of

Figure 6. Ohio River profile for the future

the new high lift locks and dams are completed. At present we have 13 new ones in operation along with 8 of the old style. The locks have been completed and the dams are under construction at Hannibal, Willow Island, and Smithland. Gallipolis and Emsworth are under study for replacement. There are some 80 locks and dams in operation for navigation on the Ohio River and its tributaries.

The second task of the ORD is flood control along the main stem and the tributaries. Flood control is accomplished by local protection projects, channel improvements, and multipurpose reservoirs.

Figure 7 shows how Tell City, Indiana, looked during the 1937

Figure 7. Tell City, Indiana, 1937 flood

flood. Most of the downtown area was underwater.

Figure 8 shows Tell City during the 1964 high water when the river rose to 14 ft above flood stage after we had completed the floodwall. Practically the entire city was protected.

Probably the most important part of our flood control program is the construction of multipurpose reservoirs on the tributaries of the Ohio. Nolin Reservoir in Kentucky, during the 1964 flood, held back

Figure 8. Tell City, Indiana, 1964 high water

the muddy runoff from doing damage downstream.

Figure 9 shows Nolin Reservoir a few months after the flood. Water held back in time of flood can be used for some useful purpose, such as water supply, low flow augmentation, or recreation.

Our flood control projects include earth-fill dams, rock-fill dams, concrete gravity dams, and one concrete faced, rock-fill dam under construction. The Center Hill Lake in Tennessee, one of our projects, operates for flood control, water quality enhancement, hydropower, and recreation benefits.

So far we have completed 64 reservoirs and have another 18 under construction. We have also completed 82 local protection projects and have 11 now under construction.

The generation of hydroelectric power is another element of comprehensive water resources development. Hydropower is included not only in reservoirs but locks and dams along the Ohio and its tributaries. Some are privately owned, operating under lease with the Federal Government; others are operated by this Division. The total capacity of the Corps

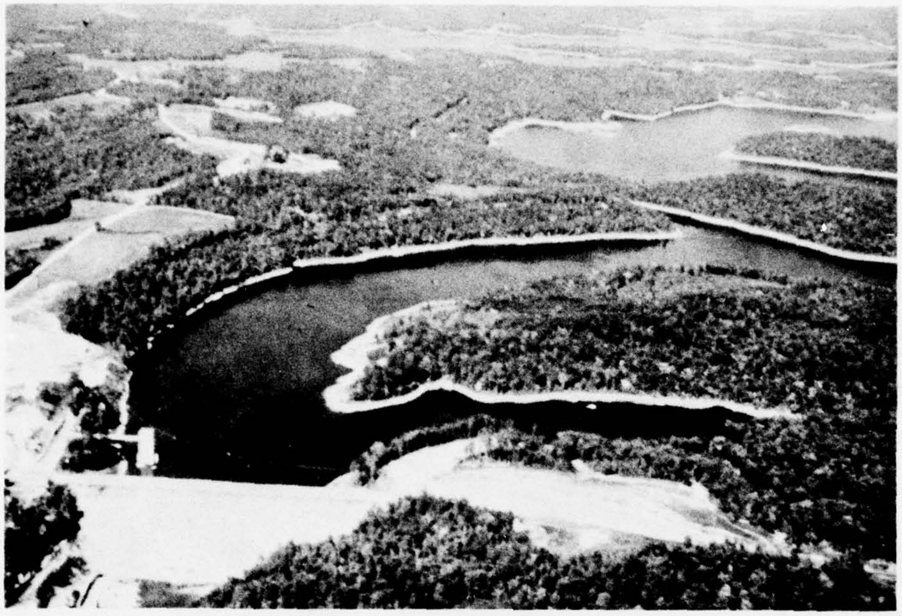

Figure 9. Nolin Reservoir, Kentucky

of Engineers plants in the Ohio basin is 914 Mw. Private power capacity using Corps projects totals about 532 Mw. The total non-Federal capacity throughout the basin is approximately 54,000 Mw.

At reservoirs and along the navigable tributaries, we try to provide launch ramps along with basic recreation facilities such as picnic facilities, campgrounds, and beaches.

More people visit Corps of Engineers projects than visit our National Parks and we are trying to keep up with them. In 1950, in this Division, we had 1,000,000 visitors; in 1960, we had 20,000,000; in 1970, we had 65,000,000; in 1972, we had 68,900,000; and last year, we had 72,000,000. When all our planned projects are completed, we expect some 306,000,000.

In all of these efforts the computer is an important tool in accomplishing the work load of the ORD. Each of the Districts has a G-225 computer, combined with time-sharing and batch capabilities at various computer centers. Computer Sciences Corporation (INFONET), Waterways Experiment Station, and GSA--Atlanta, are a few of the time-sharing and batch facilities available.

These computers are heavily used during the winter and spring to predict flood crests and reservoir discharges during the flood season. This operation is coordinated through Cincinnati to reduce flood crests on the Ohio and Mississippi Rivers and tributaries.

These same computers are also used extensively for design of navigation projects, reservoir projects, and their appurtenances. There is no Division coordination of computer program development and the programs available at the District level have been developed by the District or obtained from cooperating agencies. The total number of programs available within the Division is 74. However, many of these programs are obsolete due to changes in design criteria or design codes. Many of the programs have been obtained from one District and altered slightly by another District; many similar programs are listed. There is a need for revision of obsolete programs and a need to review the similar programs and develop one which would satisfy all needs. The revisions should be done by a District with funds furnished by OCE and monitored by the Division.

The most important programs are the ones the Districts use to design lock walls, dam piers, crest tainter gates, conduits, and highway bridges. The lock-wall program is actually two programs: one for the design of the land walls, which have earth loads on one side, and another for the middle and river walls. These programs, using input for the shape of the wall, recesses, and loading conditions, select base width, heel and toe dimensions of the walls for foundation pressure, stability, and sliding criteria of the base elevations selected. This saves considerable design time; the wall monoliths are generally repetitious except for the variation in base elevation. The reinforcing for the base, toe, heel, and at recesses such as culverts, must still be computed by the engineer. A program for computing the reinforcing would be beneficial.

Tainter gates for navigation dams or gated reservoir spillways are a problem due to the geometrics involved. Two computer programs are used to complete this design; one program to determine the girder spacings so that negative moments are balanced, another program to design

the girders and the struts of the frame. These programs also save much time since all of the gates on a project are the same.

Most earth-fill or rock-fill dams have a cut and cover conduit, or tunnels through an abutment, to provide normal control of the reservoir. These conduits or tunnels may be circular, horseshoe, or oblong in shape and are quite a chore to analyze manually. The computer programs available are very helpful in determining the stresses in the liner so that reinforcing can be designed.

Many of our projects require extensive road relocations and new bridges. The bridges to our control towers and across our spillways must also be designed. Depending on the span, load, and cost, these bridges have steel girders or prestressed concrete girders. The several programs for design and analysis of bridges make the economical design of the bridge quite a bit easier for the engineer.

As indicated, the ORD uses computers extensively in the design of its projects. However, there are several fertile areas for the development of new programs which would be beneficial. These areas are: (a) design of reinforcing for lock walls, (b) stability analysis for spillway piers, (c) design of trunnion girders, (d) design of trunnion anchorage systems, (e) stability analysis of floodwalls, and (f) loading analysis for drainage pipe.

Economical design is the objective of the engineer and a computer with proper programs can be of monumental assistance to him. An accurate Corps-wide listing of computer program abstracts would be a valuable tool to increase the use of computers in design work and, therefore, the economy of the project.

SOUTH ATLANTIC DIVISION

AD-A031 246 ARMY FOREIGN SCIENCE AND TECHNOLOGY CENTER CHARLOTTE--ETC F/G 9/2
CORPS-WIDE CONFERENCE ON COMPUTER-AIDED DESIGN IN STRUCTURAL EN--ETC(U)
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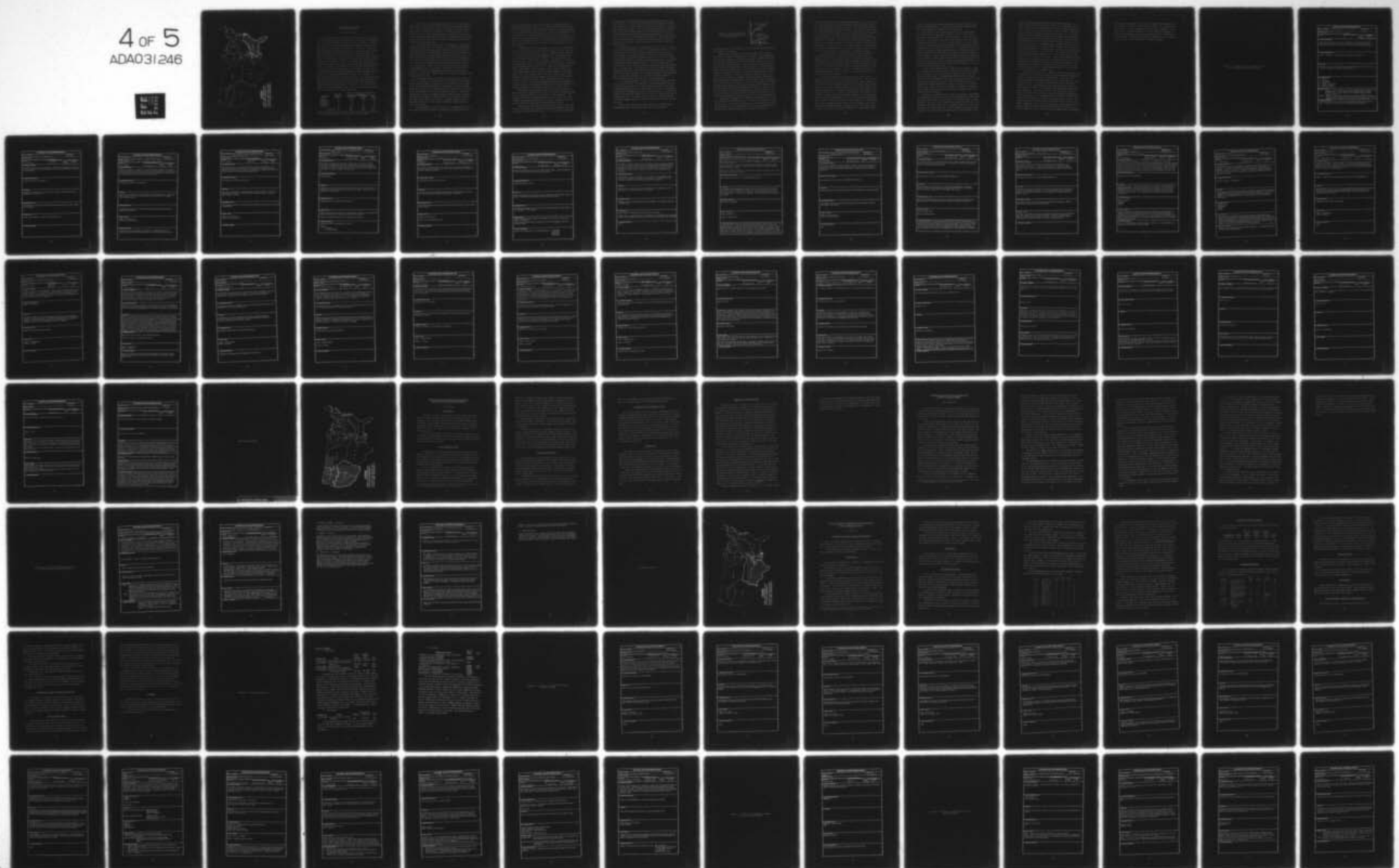

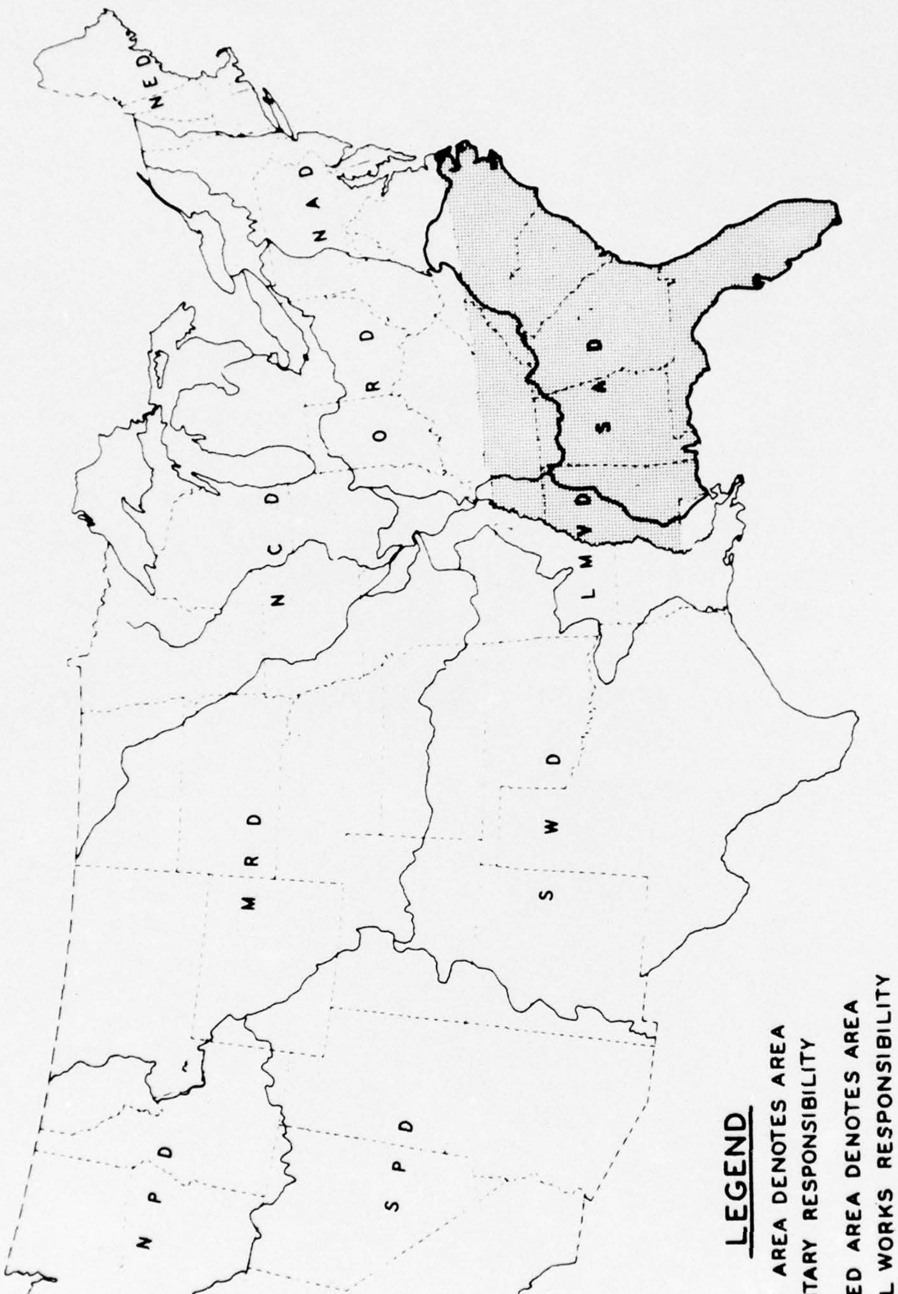
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SHADED AREA DENOTES AREA OF MILITARY RESPONSIBILITY
OUTLINED AREA DENOTES AREA OF CIVIL WORKS RESPONSIBILITY

SOUTH ATLANTIC DIVISION

By

James G. Lewis*

I certainly welcome the opportunity to participate at this conference and I am sure that by the time we leave at the end of the week we will have a good exchange of ideas on the use of computers. I would like to cover the area of responsibilities assigned to the SAD Office; this includes civil and military projects. In addition to CONUS, we have civil works responsibility in Puerto Rico and the Virgin Islands, and military construction responsibility for the Panama Canal Zone. Within our Division, we have five Districts: Mobile, Alabama; Jacksonville, Florida; Savannah, Georgia; Charleston, South Carolina; and Wilmington, North Carolina. All of these Districts have civil works responsibility; however, only Mobile and Savannah have military responsibility. The types of civil works projects currently under design or construction include inland waterways, flood control projects, multipurpose reservoirs, intercoastal waterways, harbors, and beach erosion protection. The Tennessee-Tombigbee waterway is our largest civil works project and includes nine navigation locks. Two of these projects have been awarded and the remaining are currently being designed. We support 16 military installations; the majority of the work includes troop and family housing, medical facilities, and all the structures required for today's volunteer Army. The value of construction designed in FY 75 is shown in the following tabulation.

District	Structural Engineers	Value of Construction Designed FY 75 (Millions) Civil Works	Military	Total
Mobile	29	$140	$146	$286
Savannah	11	16	170	186
Jacksonville	10	34	--	34
Wilmington	3	27	--	27
Charleston	1	14	--	14
Div. Off.	4	--	--	--
SAD Total	58	$231	$316	$547

* Chief, Structural Section, South Atlantic Division (SAD).

Craters Project, located about 90 miles north of Atlanta was designed and constructed by the Mobile District. The main dam, approximately 2000 ft long and 450 ft high, is the highest earth- and rockfill dam east of the Mississippi River. Other major features of this project are: A concrete gravity emergency spillway with five 42-ft-wide by 36-ft-high tainter gates; a powerhouse equipped with four 125-Mw turbine generators, two of which have pump capability, and four 13-ft-diameter steel lined penstocks.

During 1963, preliminary studies for replacement of the obsolete Bankhead Lock were made. The stability of the existing concrete dam, constructed in 1911, was analyzed by current criteria. This analysis indicated that the structure would be unstable for the theoretical design flood condition. Investigation revealed that the concrete in the existing dam was in excellent condition and that the most economical plan would be to rehabilitate the existing dam and replace the obsolete lock. The dam was strengthened by installing posttensioned anchors into the foundation. About 150 posttensioned anchors were installed at approximately 5-1/2 ft on center. These anchors consisted of 90 parallel, 1/4-in.-diam, high-tensile steel wires having an ultimate strength of 240,000 psi. Rehabilitation of the dam was completed by the Mobile District in 1970.

Fort Campbell hospital, currently under design by our Mobile District, is the largest single project in the FY 77 MCA program and the current working estimate on this project is $71,000,000. As a result of the recent earthquake experiences in California, and the resultant damage and inability of the affected hospitals to function, this hospital is being designed not only for structural stability. The design should enable critical life-supporting activities to remain completely functional in a disaster of major proportion so the hospital can serve as a postdisaster center for the area. A dynamic analysis, based on historical evidence of the New Madrid earthquake is being used as a basis of this design.

The Savannah Harbor tide gate structure is constructed across the back bay near Savannah, Georgia. The purpose of the structure is to

allow the flood tide to enter the river and to prevent the ebb tide from flowing to the bay. When the tide gates are closed, the ebb tide will be forced through the Savannah River, which will keep sedimentation to the minimum. The structure includes 14 tide gates, separated by 3-ft concrete piers, an earthen embankment at each end of the tide gate structures, and a control house. The design of this structure was completed by the Savannah District. The tide gates are 40 ft wide by 28 ft high. The gates rotate about pins, which are located about 9 ft from top of the gate.

A few pumping stations were designed and built by the Jacksonville District and turned over to the central and southern Florida flood control district for operation. This type of pumping station is designed to operate against a head of approximately 7 ft. The combined capacity of the three 1000-hp units is 2800 cfs. The primary purpose of these facilities is flood control; however, conservation of fresh water is an important benefit. A field research facility is being constructed by our Wilmington District for the U. S. Army Coastal Engineering Research Center (CERC). This facility is sited on the North Carolina coast approximately 60 miles north of Norfolk, Virginia. The project consists of a pier extending 1840 ft into the Atlantic Ocean, a small laboratory building and an instrumented vehicle which will travel the length of the pier. Operation of this facility will provide for collection of data on all coastal phenomena ranging from wave dynamics and littoral processes to storm surge generation. The pier was designed to withstand wave and wind loadings associated with a 100-yr storm.

Many structures were designed and constructed by the Corps for NASA at the John F. Kennedy Space Center. The vehicle assembly building was the largest building in the world when it was constructed. Four rockets such as used in manned flights to the moon can be vertically assembled simultaneously within this building. Assembled rockets are moved by crawler to launch pads from which they are fired.

Special structural design conditions in the Division include hurricane force winds, such as Eloise, which you witnessed the other day, and seismic zones which vary from 0 to 3. The SAD contains areas with

two major types of foundation problems, namely cavernous limestone and eutaw foundation. The cavernous limestone presents problems of foundation subsidence or collapse beneath structures and problems of excessive underseepage beneath dams. There is an outcrop area about 8 to 12 miles wide of the eutaw formation which extends from central Georgia across central Alabama up through Mississippi and into Tennessee. This formation is noted for its susceptibility to landslides. The material is very dense in place; however, the shale beds contained within the formation are full of slickensided surfaces which cause it to have a very low shear strength.

The Structural Section in the Division Office is one of 9 sections in the Technical Engineering Branch of the Engineering Division. In the Structural Section we have 4 structural engineers, including myself. Our assignment is quite unique as we coordinate the military construction program, have technical responsibilities in the civil and military field, and coordinate the research and development program. The military construction project management includes: (a) coordination with OCE, the Districts, and the major commands; (b) monitoring schedules and funding; (c) coordination of SAD reviews; (d) review of concept design for conformance with 1391's directive and design instructions, also checking the scope and funds available; (e) attending meetings, such as predesign and concept review conferences; (f) serving on selection teams for family housing; and (g) participation in field inspections.

Civil works assignments include: (a) structural design verification, (b) coordination of and approval of design memoranda and approval of plans and specifications, (c) participation in periodic inspections and design conferences, and (d) keeping the staff informed of structural problems and recommending solutions. With the breadth of responsibility assigned the Structural Section, we are unable to accomplish all that is required because of our limited staff of 4 people. The military work load always demands immediate attention and our priorities lean in that direction.

Figure 1 shows the trend in work contracted to architectural-engineering firms. We have been forced into this contractual

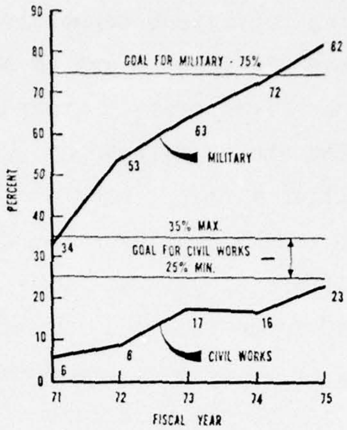


Figure 1. Percent of SAD total engineering effort accomplished by A-E contract

assignment because of the volume of our work load and limitations placed on the number of personnel.

Equipment-wise, SAD has the standard Honeywell G-437 computer system with a Datanet-30 communications controller. Data communications are provided to Wilmington, Charleston, Savannah, and Mobile Districts via dedicated telephone lines. The Jacksonville District uses the FTS system. COEMIS F&A subsystem for our five Districts requires approximately 90% of the computer time. The remaining time is divided among COEMIS P/A, RA/PM, engineering, Provost Marshall, and program modifications and development. Almost all engineering applications are processed by the Districts on other host computer systems, such as: Computer Science Corporation (INFONET), Lawrence Radiation Laboratories, National Bureau of Standards, NASA at Cape Kennedy, Slidell, Louisiana, and a few other local contractors. Access to these systems is provided by remote batch terminals, the District Honeywell G-225 computer, or by various makes of time-sharing teletype-like terminals. While the SAD ADP Center processes a few engineering applications, the Districts do just the reverse. They have applications in all the technical fields and various management information systems for their project managers.

Insufficient documentation of existing programs appears to be the major deterrent in expanding the use of computers in structural design. This problem is of particular significance in the small Districts with limited experience in the development and/or use of computer programs. The structural engineer, especially in the small district, not

foreseeing sufficient repetitive applications within his District, often feels that his problem can be solved quicker manually than by computer if he must first write a program, than try to decipher an existing program. The abstracts have not been documented well enough to allow someone familiar with the program to use it. The person writing the abstract needs to insure that all instructions are included on the use, data needed, limitations, data provided, and all other possible questionable features of the program. One of the major deterrents to writing, documenting, or using more programs has been lack of time and funds for this purpose due to the work load of the Structural Sections. Since funding for computer programs must come out of project funds, the Districts are hesitant to spend funds for documentation of a workable program.

In spite of current and past problems encountered, future use of the computer in structural design and analysis is looked upon with optimism. With the recent acquisition of new time-sharing terminals, new computer service bureaus are being investigated to determine if they can provide the specific programs needed for current and future design projects. As you are aware, work loads are increasing without a corresponding increase in manpower. In order to increase the production capability of present staff, we expect to use computer facilities, particularly time-sharing systems.

In the area of program development costs and computer accessibility, it may be possible to turn to industry for help. In most design applications, private industry experiences the same design problems as the Corps. Therefore, computer programs may be available from industry that will meet Corps requirements with little or no modification. This would minimize the cost of developing new programs and thereby reduce program funding costs. In order to provide better accessibility to the computer, industry software and hardware contracts could be negotiated at OCE level rather than District level. This would provide many advantages to users, such as a Corps-wide catalog system with programs available from all computer service vendors listed by subject, output equipment needed, and extra equipment available to match more sophisticated programs. This would also allow establishment of a Corps-wide library

of both Corps-developed programs and programs needed by District, with library costs shared by all. Also, with a Corps-wide negotiated contract, time-sharing costs should be more economical.

Time sharing, it is believed, will grow a lot in coming years, particularly with the upgrading of Corps facilities. This should develop into the engineer's most useful design aid. In the past, the batch processor has been a real help to the engineer, but, time sharing is much more attractive. However, if time sharing is to be used effectively, the following items must be provided: (a) time-sharing oriented training which can be obtained from vendors at a reasonable cost; (b) a catalog of programs, as mentioned earlier; (c) up-to-date abstracts with program capabilities defined clearly and simply; (d) better communications, telephone or other, between time-sharing terminals and computers; (e) a convenient location within the work area for the time-sharing terminal; and (f) vendor conducted training by engineering discipline. All of the items mentioned above plus others should be provided in a manner which will make the computer easy to use.

A major problem shared by many Districts is the failure to fully use the computer in project designs. Some Districts have been attempting to encourage the use of the computer through training, but, this is often an up-hill battle. Young engineers who have had the required training do use the computer; older engineers, who are often team leaders and supervisors, generally have not had the training and are not as familiar with program capabilities. Therefore, they tend to shy away from its use. Some Districts are attempting to familiarize everyone with program capabilities plus provide needed equipment in hopes that computer use will increase.

Several of our Districts have tackled the problem of coordination by designating an ADP coordinator for every organizational staff element and major branch element in the District. We recognize that, in many instances, the staff chief or branch chief does not have the time to research his ADP needs. Therefore, he designates someone to assist him in this matter on a part-time basis. These coordinators serve as special advisors to their respective organization and to the ADP center on all

matters concerning data processing. Their functions include: (a) a monthly review of all ADP activities within their organization; (b) a review of abstracts of new programs placed in the engineer computer programs library at WES and other programs listed in EP 18-1-3 (Engineer computer program listing); (c) advising the branch chief of ADP applications that offer potential benefits to the branch; (d) advising employees within the branch on programming techniques, available manuals, and standard procedures for accomplishing a computer run; and (e) advising the ADP Center on programming needs, equipment needs, and training needs of the branch and suggest ways of improving ADP services, to the operating elements. These branch ADP coordinators are considered to be the "eyes and ears" of the ADP Center. Even though this is a part-time function for these employees, their interest and suggestions make the job of the ADP Center a lot easier. While the big computers and big programs are providing services now considered essential, we have found that desk-size programmable electronic calculators are capable of producing problem solutions in a few minutes which previously would have taken a half day or more of conventional calculations or a day or more of turnaround time at the computer center.

In conclusion I would like to make the following observations and recommendations. In view of the many actual and potential advantages in the use of computers in structural engineering, a concerted effort should be made at every echelon within the Corps to encourage its use to the optimum extent. To minimize duplication of effort, some control measures are also needed; however, these control measures should be of a nature that will tend to encourage rather than discourage the extended use of computers. To be most effective in minimizing duplication of effort the control and coordination should be centralized and applied on a Corps-wide basis. It is recommended that OCE through the WES library make a study of Corps or commercial programs currently available. These programs should be reviewed, giving due consideration to such factors as design assumptions, Corps criteria, design codes, and standardization of design. Where duplication exists a determination should be made as to which programs are better, then appropriate programs should be catalogued

and thoroughly documented. WES should also monitor the development of new programs to limit future duplication of effort. It is realized that implementation of these recommendations would require funding. It appears that it would be appropriate for OCE to fund the development of computer programs which have broad application similar to OCE funding of R&D program. Implementation of these recommendations would encourage and control the use and development of computer programs.

Appendix A: Abstracts of South Atlantic Division Structural Engineering Computer Programs

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.
Analysis of Vertical Lift Gate			GS10
PREPARING AGENCY			
U. S. Army Engineer District, Jacksonville			
AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STATUS OF PROGRAM: STAGE
		Complete	Operational

A. PURPOSE OF PROGRAM

This program analyzes the structural ability of a vertical lift gate by computing the moments, reactions, and stresses within the gate and the roller reactions on the gate which result from specified loading conditions.

B. PROGRAM SPECIFICATIONS

GE-225 - FORTRAN IV, fixed format, floating point arithmetic.

C. METHODS

Reactions, stresses, and moments are computed through successive iteration of standard engineering formulas and procedures.

D. EQUIPMENT DETAILS

1. GE-225
2. Card read
3. Card punch
4. Magnetic tape units
5. Console typewriter
6. On-line printer

E. INPUT-OUTPUT

Input - Weight of water, headwater, tailwater, maximum number of channel spans, maximum number of roller spans, clear opening of gate, distance between rollers at gate opening, section modulus of skin plate, vertical channels.

Output - Moments in skin plate, reactions at horizontal channels, plate and beam stresses, combined plate and beam stresses, moments in vertical channels, roller reactions, and stress in vertical channels.

F. ADDITIONAL REMARKS

Due to the amount of input required some preliminary computations must be made to determine spacing and the various member sizes required.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.
Intersection of Spillway and Tainter Gate			13-G1-C514
PREPARING AGENCY			
U. S. Corps of Engineers, Savannah District			
AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STAGE
Harold Willet	Jan 1965	Initial	OP

A. PURPOSE OF PROGRAM

The program computes the coordinates of the point of intersection of Tainter Gate and Spillway and the angle between the vertical and tangent to the point of intersection.

B. PROGRAM SPECIFICATIONS

Program is written in FORTRAN IV.

C. METHODS

An equation is solved by trial and error. Answer is assumed correct when remainder is less than 0.1.

D. EQUIPMENT DETAILS

The equipment required is the GE-225 data processing system, GE card reader, and GE printer.

E. INPUT-OUTPUT

Input is by cards only. Output is by printer only.

F. ADDITIONAL REMARKS

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM	PROGRAM NO.
Load, Shear and Moment Diagrams - 3 Girder Tainter Gate	13-G1-G504

PREPARING AGENCY

Tulsa District Office, Corps of Engineers, Tulsa, Oklahoma

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STATUS OF PROGRAM: STAGE
W. P. Johnson J. R. Jones	October 1963	INIT	OP

A. PURPOSE OF PROGRAM

This program gives the complete rib shear and moment diagrams for a three girder tainter gate. Loads are water to the top of the gate, a sill reaction at the bottom of the gate, and wave action. The program may converge until the negative moments are within the allowable limits.

B. PROGRAM SPECIFICATIONS

The program is written in GE-225 WIZ.

C. METHODS

The ribs are analyzed as a straight member over three supports. The actual water pressure is used at each end and at the supports with a straight line variation between.

D. EQUIPMENT DETAILS

The equipment required is the GE-225 data processing system, GE-225 card reader and GE printer.

E. INPUT-OUTPUT

Input is by cards only.
Output is by printer only.

F. ADDITIONAL REMARKS

This program is a refinement and expansion to "Optimum Location of Girders for a Three Girder Tainter Gate" by Ft. Worth District, May 1961.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM: Load, Shear, and Moment Diagrams for Ribs - 4 Girder Tainter Gate	PROGRAM NO.: 13-G1-G505

PREPARING AGENCY: Tulsa District, Corps of Engineers, Tulsa, Oklahoma

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STATUS OF PROGRAM: STAGE
W. P. Johnson	Jan 1962	INIT	OP

A. PURPOSE OF PROGRAM

This program gives the complete rib shear and moment diagrams for a four girder tainter gate. Loads are water to the top of the gate and a sill reaction at the bottom of the gate. The program may converge until the four negative moments are within the allowable limits.

B. PROGRAM SPECIFICATIONS

The program is written in GE-225 WIZ.

C. METHODS

The ribs are analyzed as a straight member over four supports. The actual water pressure is used at each end and at the supports with a straight line variation between.

D. EQUIPMENT DETAILS

The equipment required is the GE-225 data processing system, GE-225 card reader and GE printer.

E. INPUT-OUTPUT

Input is by cards only.
Output is by printer only.

F. ADDITIONAL REMARKS

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM		PROGRAM NO.
Angle of Chain Pull and Chain Contact for Tainter Gate		13-G1-G508

PREPARING AGENCY
U. S. Corps of Engineers, Tulsa District

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STATUS OF PROGRAM: STAGE
Joseph Hill	January 1963	1st	Final

A. PURPOSE OF PROGRAM

This program computes (1) the angle of chain pull to vertical for both overwound and underwound hoists with gate in any position from closed to full open; (2) angles and distances associated with gate in each position; (3) length of chain in contact with gate and (4) perpendicular distance from centerline of chain to center of trunnion pin.

B. PROGRAM SPECIFICATIONS

GE WIZ program.

C. METHODS

Exact angles are computed by algebraic and trigonometric relationships and answers are printed in degrees and decimals of a degree. Distances are in same units as input data.

D. EQUIPMENT DETAILS

Computer should be a GE-225 with card input.

E. INPUT-OUTPUT

Input is specified by continue to read statements so data may be entered with as many cards as desired so long as sequence is maintained.

Output is explained by print label statements on print out.

F. ADDITIONAL REMARKS

Computation time is approximately 1 minute.

Available
1. Write up
2. Source Program

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.
Circular Conduit Analysis			13-G1-G515
PREPARING AGENCY Tulsa District, Corps of Engineers			
AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STAGE
Joseph Hill John Tang	February 1964	Initial	OP

A. PURPOSE OF PROGRAM

The purpose of this program is to compute shears, thrusts, and moments at each voussoir (due to water and earth load above the top of conduit) for circular ring type conduit.

B. PROGRAM SPECIFICATIONS

The program is written in GE-225 WIZ.

C. METHODS

The circular conduit analysis computations are obtained using the method developed in the Corps of Engineers Manual EM 1110-2-2902.

D. EQUIPMENT DETAILS

The equipment required is the GE-225 data processing system, GE card reader, and GE printer.

E. INPUT-OUTPUT

Input is by cards only.

Output is on printer paper only.

F. ADDITIONAL REMARKS

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.
Overflow Stability Cases I and II			13-G1-G517

PREPARING AGENCY

U. S. Corps of Engineers, Tulsa District

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM	
		PHASE	STAGE
Joseph Hill	March 1964	Initial	OP

A. PURPOSE OF PROGRAM

This program computes the vertical weight volumn, moment, and base pressures for the overflow monolith of a gravity dam design.

B. PROGRAM SPECIFICATIONS

Program is written in WIZ.

C. METHODS

Forces are determined by current criteria, geometric, and algebraic relationships. Frequently changed coefficients are entered as data.

D. EQUIPMENT DETAILS

The equipment required is the GE-225 data processing system, GE card reader, GE card punch, and GE printer.

E. INPUT-OUTPUT

Input consists of output cards from Program No. 13-G1-G506, constants, and section coordinates.

Output is printed and cards are punched for input of Programs 13-G1-G519 and 13-G1-G520.

F. ADDITIONAL REMARKS

This is the second part of a 4-program sequence: 13-G1-G506
13-G1-G5M7
13-G1-G519
13-G1-G520

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM	PROGRAM NO.
Batter Pile Analysis - Hrennikoff	713-G1-K6020

PREPARING AGENCY
U. S. Army Engineer District, Savannah, Ga.

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM PHASE	STATUS OF PROGRAM STAGE
R. W. Powers Thomas J. Durrence	June 1963		

A. PURPOSE OF PROGRAM

This program computes the pile constants based on any pile section required to be used in further computation of the longitudinal and transverse loads, compiles the three equations, solves them simultaneously for the reduced foundation movements and computes the axial load, shear and moment for the battered or vertical piles. Analysis is made for fixed and pinned end conditions.

B. PROGRAM SPECIFICATIONS

This program is written in FORTRAN. It is limited to ten different pile groups with a maximum of 20 piles in each group. This limitation can be removed by changing the dimension statement in the program.

C. METHODS

ASCE Transactions, Volume No. 115, 1950, Paper No. 2041 Analysis of Pile Foundations with Batter Piles by A. Hrennikoff.

D. EQUIPMENT DETAILS

Equipment includes a GE-225 computer with 8K memory, card reader, punch and 900 LPM printer.

E. INPUT-OUTPUT

Input consists of dimension of pile system to be checked.

Output consist of identification, pile properties, longitudinal and transverse loads, batter, distance of pile from moment center and computed pile constants.

F. ADDITIONAL REMARKS

None

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.	
Culvert Design			13-61-K650	
PREPARING AGENCY: North Carolina Highway Department				
AUTHOR(S) Larry A. Colbert, adapted @ Savannah District by Fred Kitchens	DATE PROGRAM COMPLETED	STATUS OF PROGRAM		
	May 1970	PHASE	STAGE	

A. PURPOSE OF PROGRAM

This program will design a single or multiple box culvert, knowing the span, height, and fill. It will also give the bar schedule as an option, knowing the length and end skews.

The output includes thickness of slab and wall, concrete volume per foot, steel weight per foot, and bar details.

B. PROGRAM SPECIFICATIONS

The program is written in GE card FORTRAN (FORTRAN II).

C. METHODS

The culverts are designed using formulae based on Hickersons Method of Moment Distribution, with a variable "R" ratio. A fixed base condition is assumed, and the top half of the culvert is designed. The bottom half of the culvert is made the same. If there is no floor slab, then a half-fixed base condition is assumed.

D. EQUIPMENT DETAILS

Same as for 1361-M635.

E. INPUT – OUTPUT

Input by cards only.

Output by printer only.

F. ADDITIONAL REMARKS The live load may vary from HS20 to H10, or none at all. The design moments and required slab and wall sizes may be printed as an option. Normally the bar schedule is given but this may be omitted if desired. You may designate your own numbering system for "A" bars. You may give special values for stresses, weight and pressure of earth. You may enter a special live load axle with or without an overstress factor, to be used in addition to the regular live load. You may enter fixed or minimum values for each culvert slab or wall.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM Circular or Oblong Shape Conduit Design Under High Fills

PROGRAM NO. 13-G1-K635

PREPARING AGENCY
Savannah District

AUTHOR(S)
Fred Kitchens
Bob Halliburton

DATE PROGRAM COMPLETED March 1969

STATUS OF PROGRAM

PHASE	STAGE

A. PURPOSE OF PROGRAM

This program computes the moments, thrusts, shears, steel required, concrete stress, steel stress and diagonal tension stress at 15 degree increments around the conduit for a given conduit radios, concrete section and loading condition.

B. PROGRAM SPECIFICATIONS

The program is written in GE Card FORTRAN (FORTRAN II).

C. METHODS

Using the elastic center method of analysis and working stress concrete design.

D. EQUIPMENT DETAILS

The system consists of a GE-225 central processor with 8K memory, 400 CPM card reader, and printer.

E. INPUT - OUTPUT

Input is by cards only.
Output is by printer only.

F. ADDITIONAL REMARKS

None.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM Spread Footing Design - Working Stress	PROGRAM NO. 13-G1-K605
PREPARING AGENCY Savannah District	

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM PHASE	STAGE
Fred J. Kitchens	February 1966		

A. PURPOSE OF PROGRAM

The problem consisted of determining the depth, required reinforcement size and spacing, and actual bearing pressure for a footing of a given size with given loads and allowable bearing pressure.

B. PROGRAM SPECIFICATIONS

The program is written in GE Card FORTRAN (FORTRAN II).

C. METHODS

The method of solution for the line of zero bearing pressure is based on Paper No. 3239 Analytical Approach to Biaxial Eccentricity by E. Czerniak, ASCE Proceedings, Volumn 88, No. ST4, August 1962, Part I.

D. EQUIPMENT DETAILS

The Data Processing System used by this program consists of a GE-225 Central Processor with 8K memory, card reader, card punch, and 900 LPM Printer.

E. INPUT - OUTPUT

Input by cards only.

Output by printer only.

F. ADDITIONAL REMARKS It was required that provisions be made for variation in footing dimensions, allowable concrete and steel stresses, ACI Code to be used, control of reinforcement spacing and size, and loading. The load could consist of an axial load with or without a bending moment about one or both axes. It was also required that if the actual bearing pressure exceeded the allowable, the footing would be resized and redesigned for a pressure within the allowable.

ELECTRONIC COMPUTER PROGRAM ABSTRACT			
TITLE OF PROGRAM Cantilever Retaining Wall - Part I and II			PROGRAM NO. 713-G1-K6130
PREPARING AGENCY Savannah District			
AUTHOR(S) Kitchens, Fred J.	DATE PROGRAM COMPLETED February 1965	STATUS OF PROGRAM PHASE	STAGE

A. PURPOSE OF PROGRAM

The program consists of determining the base and stern dimensions and reinforcement necessary to satisfy the requirements of stability, flexure, and shear in the design of a cantilever retaining wall for given loadings. The program will allow 5 different types of soil behind and in front of the wall.

B. PROGRAM SPECIFICATIONS

The program is written in GE Card FORTRAN (FORTRAN II).

C. METHODS

The method is in accordance with the criteria set forth in EM 1110-2-2502 for sliding, overturning, and stability. The soil pressures may be entered as input (result of wedge analysis) or may be computed in accordance with the Rankine analysis.

D. EQUIPMENT DETAILS

The system consists of a GE-225 central processor with 8K memory, 400 CPM card reader, card punch and 900 LPM Printer.

E. INPUT - OUTPUT

All input is on cards and consists of soils and concrete data, wall elevations and fixed dimensions and loading conditions. The output consists of stem and base thickness and dimensions and moments, shears and reinforcement requirements at one foot intervals for both the stem and base.

F. ADDITIONAL REMARKS

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.
Overflow Monolith Stability			713-G1-K6370
PREPARING AGENCY			
Savannah District, Corps of Engineers			
AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM	
		PHASE	STAGE
B. J. Halliburton	January 1970		

A. PURPOSE OF PROGRAM

The purpose of this program is to determine the stability of an overflow monolith at the plane of the base and at any horizontal plane up to and including the plane where the pier toe intersects the curve of the weir. The program will compute the stability of a weir only, on ungated spillway with piers for bridge support, and a gated spillway. It will compute the stability for the construction condition, normal operating condition, induced surcharge condition, flood discharge condition, and maintenance condition all simultaneous or either one or ones as desired.

B. PROGRAM SPECIFICATIONS

Program is written in FORTRAN II.

C. METHODS

The method of analysis generall yfollows the outline given in EM 1110-2-2200, Gravity Dam Design. The weir equations used are as given in EM 1110-2-1603, Appendix III, PL 1 and 2 and the pier nose may be either of the first three type shapes shown on PL 7 of this same EM. A flip bucket may or may not be monolithic with the weir. Wave computations are based on Sainflou's method of analysis.

D. EQUIPMENT DETAILS

GE-225 - 8K CPM
Card Reader
Printer
4-Tapes

E. INPUT - OUTPUT

Input consists of the monolith geometry, pool elev-tions for the desired conditions of stability, soil data and different codes for program decision making for the use of wind and wave, wind and ice, or other combinations, for type weir and upstream face of weir, etc. Output consists of all forces acting on the structure, location of the resultant and base stresses for all desired conditions of stability.

F. ADDITIONAL REMARKS

This is a chain program, requiring chains 1 through 8. It all requires tape handlers 3 and 4 for use as scratch tapes.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.
Non-Overflow or Intake Monolith Stability			713-G1-6380
PREPARING AGENCY Savannah District, Corps of Engineers			
AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STAGE
B. J. Halliburton	January 1970		

A. PURPOSE OF PROGRAM

This program was written to determine the forces, moments and location of the resultant for either a non-overflow or intake monolith. The program is designed to compute the stability at any given horizontal plane through the monolith as well as at the base. Wind, wave, headwater, tailwater, upstream soil, downstream soil, uplift, mass forces, and base stresses are all computed by the program.

B. PROGRAM SPECIFICATIONS

Program is written in FORTRAN II.

C. METHODS

The method of solution for the stability analysis is based upon EM 1110-2-2200. Wave computations are based upon Sainflou's Method of Analysis. The waves are assumed to be non-breaking waves. The soil routines are written with the flexibility of allowing from zero to two soil stratas up and downstream of the monolith.

D. EQUIPMENT DETAILS

GE-225 8K CPM
Card Reader
Printer
4-Tapes

E. INPUT-OUTPUT

Input consists of information defining the geometry of the monolith pool elevations, soil elevations, and information if applicable. The output consists of the magnitude of the various forces, their moment arms in terms of X, Y, and Z coordinates, their moments about the X, Y, and Z reference axis, the location of the resultant and its position with respect to the kern limits, the volume of concrete in the monolith and the base stresses.

F. ADDITIONAL REMARKS

This is a chain program, requiring chains 1 through 5. The program also uses a scratch tape, tape handler 3.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM	PROGRAM NO.
Gated Spillway Stability	713-S8-K5270

PREPARING AGENCY
U. S. Army Engineer District, Mobile, Mobile, Alabama

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STATUS OF PROGRAM: STAGE
CPT J. Gorman Schaffer, Jr.	April 1972		

A. PURPOSE OF PROGRAM

To provide user with a three-dimensional stability investigation of an intermediate pier monolith. Output includes: (1) description and magnitude of forces acting on the monolith; (2) resultant of forces and moments; (3) base pressures and shear-friction safety factor; and (4) base pressure adjustment if part of base is in noncompression.

B. PROGRAM SPECIFICATIONS

Computer - UNIVAC 1108 or any computer capable of compiling FORTRAN IV.

C. METHODS

Program accepts as input detailed structure geometry and computes all concrete, water, and earth loads. Uplift and moving water forces are calculated in accordance with appropriate engineering manuals. Nonconcrete dead load weights are input as forces.

D. EQUIPMENT DETAILS

UNIVAC 1108, card reader, and printer.

E. INPUT-OUTPUT

Input - punched cards
Output - printed

F. ADDITIONAL REMARKS

None.

ELECTRONIC COMPUTER PROGRAM ABSTRACT			
TITLE OF PROGRAM Lockwall Stability - Monolith Investigation		PROGRAM NO. 722-S8-K5240	
PREPARING AGENCY U. S. Army Engineer District, Mobile, Alabama			
AUTHOR(S) Charles W. Kling	DATE PROGRAM COMPLETED Modified May 1974	STATUS OF PROGRAM PHASE	STAGE

A. PURPOSE OF PROGRAM

Provides user with a three-dimensional static stability investigation of most lockwall monoliths. Output includes: (1) description and magnitude of all forces acting on the monolith; (2) resultant of forces and moments; (3) base pressures and shear-friction safety factor; (4) base pressure adjustment if part of the base is not in compression.

B. PROGRAM SPECIFICATIONS

Computer - UNIVAC 1108

C. METHODS

Horizontal backfill is used with Rankine earth pressures. Miscellaneous forces are acceptable as input. Filling system culverts can be either full or empty. Horizontal forces parallel to the centerline of the lock are assumed resisted by adjacent monoliths and are not computed.

D. EQUIPMENT DETAILS

UNIVAC 1108, card reader, and printer.

E. INPUT-OUTPUT

Input - punched cards
Output - printed

F. ADDITIONAL REMARKS

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.
Miter Gate Design			713-S8-K5300
PREPARING AGENCY			
U. S. Army Engineer District, Mobile, Alabama			
AUTHOR(S)	**DATE PROGRAM COMPLETED**	**STATUS OF PROGRAM** PHASE	STAGE
C. Jackson Granade, Jr.			

A. PURPOSE OF PROGRAM

The purpose of program "Miter Gate Design" is to produce a structural design of the major elements of horizontally framed miter gates. The following items will be computed or designed: (1) girder loads, (2) skin plate, (3) intercostals, (4) girder sections at centerline, end diaphragm, and transition, (5) intermediate web stiffeners, (6) thrust diaphragm and stiffeners, (7) tapered end section, (8) end diaphragm and stiffeners.

B. PROGRAM SPECIFICATIONS

Programs were written in FORTRAN IV for the Univac 1108 and GE-400 computers. The object program requires approximately 16,000 36-bit words for execution on the Univac 1108 and approximately 24,000 words for execution on the GE-400.

C. METHODS

Structural design specification utilized in the program "Miter Gate Design" are in accordance with EM 1110-1-2101, or in the event of items not covered by this EM, in accordance with the 1970 edition of the publication of structured steel for buildings by the American Institute of Steel Construction, herein after referred to as the AISC Specification. The applicable allowable AISC stresses are reduced to 83% of the stresses shown in the AISC specification. Design assumptions comply with the Engineer Manual EM 1110-2-2603, Lock Gates, which is presently being prepared by the Mobile District, COE. The method used to design miter gate components by computer involves taking a minimum size section and increasing it incrementally until it is acceptable. This technique is employed in design of each item in program "Miter Gate Design."

D. EQUIPMENT DETAILS

Univac 1004 to Univac 1108 - Card reader and printer.

GE-225 to GE-400 - Card reader and printer.

E. INPUT-OUTPUT

Input - punched cards.
Output - Printed.

F. ADDITIONAL REMARKS

Program card deck may be obtained from ADP Center, Mobile District, COE. Additional information may be obtained from author of ADP Center, Mobile District, COE.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.
Truss Analysis			
PREPARING AGENCY			
U. S. Army Engineer District, Alabama			
AUTHOR(S)	**DATE PROGRAM COMPLETED**	**STATUS OF PROGRAM** PHASE	STAGE
C. Jackson Granade, Jr. David F. McDonald			

A. PURPOSE OF PROGRAM

The program structurally analyzes a joint-loaded truss, furnishing: (a) axial member forces, (b) axial member stresses, (c) joint displacements (allows determination of changes in member lengths), and (d) joint rotations.

B. PROGRAM SPECIFICATIONS

The program was written in FORTRAN IV for the CDC 6600 computer and has been modified for use with the UNIVAC 1108.

C. METHODS

The program is based on the Gensap Code prepared by Agbabian-Jacobsen Associates for Huntsville Division. The basic program was modified in order to simplify its use for truss analysis.

D. EQUIPMENT DETAILS

Data 100 to UNIVAC 1108 - Card reader and printer.

E. INPUT-OUTPUT

Input - punched cards
Output - printed.

F. ADDITIONAL REMARKS

Additional information may be obtained from the authors.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.
Three-Dimensional Pile Foundation Analysis			713-S8-K5280
PREPARING AGENCY			
U. S. Army Engineer District, Mobile, Alabama			
AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STATUS OF PROGRAM: STAGE
CPT J. Gorman Schaffer, Jr.	December 1971		

A. PURPOSE OF PROGRAM

This program provides the user with an analysis of pile foundations resisting three-dimensional forces. Batter piles are acceptable but the angles of batter are limited to one plane. A given pile foundation can be analyzed for a number of different loading conditions. The axial and transverse loads acting on any pile within the foundation can be obtained.

B. PROGRAM SPECIFICATIONS

The program is written in FORTRAN IV for the UNIVAC 1108; however, it can be run on any computer capable of compiling FORTRAN IV.

C. METHODS

Program calculates axial and transverse loads acting on all specified piles within the foundation using the Hrennikoff method. This program is a slightly modified version of the program (713-G1-M413A) written by W. C. Marak of the Little Rock District. Only the input/output is changed.

D. EQUIPMENT DETAILS

UNIVAC 1108, card reader, and printer.

E. INPUT-OUTPUT

Input - punched cards.

Output - printed.

F. ADDITIONAL REMARKS

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.
Frame Analysis			
PREPARING AGENCY			
U. S. Army Engineer District, Mobile, Alabama			
AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM	
		PHASE	STAGE
C. Jackson Granade David F. McDonald	Not yet complete		

A. PURPOSE OF PROGRAM

The program will structurally analyze frames, furnishing shears, moments, and deflections. The program is being modified by the Mobile District and will be used for single and milti-story frames, principally in the Military Construction Program.

B. PROGRAM SPECIFICATIONS

Program is not yet complete.

C. METHODS

The program is a modified version of GENSAP CODE program developed for the Huntsville Division.

D. EQUIPMENT DETAILS

Computer - UNIVAC 1108, card reader, and printer.

E. INPUT-OUTPUT

Input - punched cards.

Output - printed.

F. ADDITIONAL REMARKS

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.
Lockwall Stability - One Foot Section			22J2K518
PREPARING AGENCY			
U. S. Army Engineer District, Mobile, Alabama			
AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STAGE
J. Gorman Schaffer, Jr.	March 1971		

A. PURPOSE OF PROGRAM

To provide user with a two-dimensional static investigation of a typical lock-wall chamber section and will modify the back slope of the section until the resultant of the normal loading conditions fall inside the kern. It also provides output for individual loading conditions as follows: (1) forces; (2) resultant of forces and moments; (3) base pressures and shear-friction safety factor; (4) base pressure adjustment if part of the base is not in compression.

B. PROGRAM SPECIFICATIONS

This program was written in FORTRAN IV; however, it can be compiled on any FORTRAN IV compiler; therefore, the UNIVAC 1108.

C. METHODS

Rankine earth pressures are used with pore water treated as free water. Earth-quake loading can be combined with any other loading condition. An option is available to nullify horizontal forces if a competent rock strut is present. The program will also handle sloping bases.

D. EQUIPMENT DETAILS

UNIVAC 1108, card reader, and printer.

E. INPUT-OUTPUT

Input - punched cards

Output - printed.

F. ADDITIONAL REMARKS

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.
U-Frame Structure Design			713-S8-K5180
PREPARING AGENCY			
U. S. Army Engineer District, Mobile, Alabama			
AUTHOR(S)	**DATE PROGRAM COMPLETED**	**STATUS OF PROGRAM** PHASE	STAGE
James B. Gaines, Jr. Malcolm J. Babb	November 1962		

A. PURPOSE OF PROGRAM

To provide user with a preliminary design of a reinforced concrete stilling basin or other concrete U-frame structure. For several trial sections the program computes and prints out: (1) member sizes; (2) forces and moments on members; areas and perimeters of reinforcing steel required at various locations.

B. PROGRAM SPECIFICATIONS

The program was written in FORTRAN IV for the IBM 1620 and has been run on the UNIVAC 1108.

C. METHODS

The program uses Rankine earth pressures and the working stress method for trial sections to allow designer to select the most economical section for final design. The program is restricted to uniform base pressures and horizontal backfill surface.

D. EQUIPMENT DETAILS

UNIVAC 1108 - card reader and printer.

E. INPUT-OUTPUT

Input - punched cards.

Output - printed.

F. ADDITIONAL REMARKS

Useful only for preliminary design.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.
Composite Plate Girder Design			713-070
PREPARING AGENCY			
North Carolina Division of Highways			
AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM PHASE	STAGE
Larry A. Colbert	December 1970		

A. PURPOSE OF PROGRAM

This program will design composite or non-composite plate girders.

B. PROGRAM SPECIFICATIONS

Written in PL/1

C. METHODS

The computer first estimates a web depth (and hence thickness), then from this estimates the bottom plate area, then from this estimates the top flange area. A special routine converts each area to the most desirable width and stresses determined. Through a very complicated series of stress checkings, either the top area alone, or the bottom and top areas, are increased or decreased according to how far the stress is from the maximum. The correct plates are usually found very quickly.

D. EQUIPMENT DETAILS

Written for IBM 360/75

E. INPUT-OUTPUT

This program will give plate sizes at the centerline, and will reduce the flange plates up to three times, to give four plate sections in all. You may fix any plate size or length.

The output includes plate sizes, moments, stresses, properties, design weights per foot, live deflection at centerline, dead deflections at tenths points, shears, stiffeners, stud spacing, total weights and reaction.

F. ADDITIONAL REMARKS

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM	PROGRAM NO.
Truss Analysis - Dead and Live Loads	713-010

PREPARING AGENCY

U. S. Army Corps of Engineers, Wilmington District, Wilmington, N. C. 28401

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STAGE
J. Patrick Vennari, Jr.-St. Louis Kenneth R. Koller - St. Louis Jim Waller - Wilmington - Revised	Orig January 1968 Rev October 1971		

A. PURPOSE OF PROGRAM

The program analyzes a two-dimensional truss for stationary and moving loads.

B. PROGRAM SPECIFICATIONS

The program was written in FORTRAN IV.

C. METHODS

The stiffness method is used to compute the stress in each member due to a unit load applied at the panel points. A live load is run across the diagram in increments. The load is proportioned to the joints and the sum of these values multiplied by the corresponding stiffness value for the joints yields the total stress in the member at the increment.

D. EQUIPMENT DETAILS

At least 8K word memory, card-reader, and line printer is required.

E. INPUT-OUTPUT

The input required is the geometry of the truss, the assumed dead load and live load. Cooper railroad loadings are provided internally, but other live loads can be applied as input data. The output consists of a listing of the input data, the generated stiffness matrix and the results of the dead and the live load analysis.

F. ADDITIONAL REMARKS

Maximum of 40 members.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM
Bent Cap Analysis

PROGRAM NO.
713-080

PREPARING AGENCY
North Carolina Division of Highways

AUTHOR(S)

DATE PROGRAM COMPLETED
November 1970

STATUS OF PROGRAM
PHASE
STAGE

A. PURPOSE OF PROGRAM

This program analyses Bridge Bent Caps as a continuous beam.

B. PROGRAM SPECIFICATIONS

Written in PL/1

C. METHODS

D. EQUIPMENT DETAILS

Written for IBM 360/75

E. INPUT-OUTPUT This program will give the maximum moments and shears in a Bent Cap due to dead loads and combinations of live loads entered in lanes. Moments and shears are given at all load positions, at the centers of columns, and the faces of solumns. Additional check points may be easily obtained by entering dummy loads with zero weight.
Overall maximum negative moment is given for column faces and not column centers. The dead load output is normally followed by the maximum live load output, and then the combination of dead with maximum live load output.

F. ADDITIONAL REMARKS

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM	PROGRAM NO.
Composite Prestressed Girder	713-050

PREPARING AGENCY

North Carolina Division of Highways

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STATUS OF PROGRAM: STAGE
Larry A. Colbert	August 1972		

A. PURPOSE OF PROGRAM

This program will design or analyze a composite pretensioned prestressed concrete girder for a simple span. The girder may be AASHTO 36, 45, or 54-inch depth.

B. PROGRAM SPECIFICATIONS

Written in PL/1

C. METHODS

The computer determines the stress at the bottom of the girder at the centerline due to the loadings, and then chooses a cable pattern that will give the required prestress. The stresses under various other conditions are shown in the output, and some of these may not be acceptable (marked by an asterisk). It is up to the engineer to check these other stresses, and it may be necessary to increase the concrete strength or scrap the design.

D. EQUIPMENT DETAILS

Written for IBM 360/75

E. INPUT-OUTPUT

The normal output is for high stress grade 270 cables, 7/16" dia. for 36" and 45" girders, 1/2" dia. for 54" girders. You may get the old regular stress grade 250 cables, 7/16" dai. as an option. Standard strand patterns are normally used, but you may also use your own.

F. ADDITIONAL REMARKS

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.
Composite I-Beam Design			713-060

PREPARING AGENCY

North Carolina Division of Highways

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STATUS OF PROGRAM: STAGE
Larry A. Colbert	February 1970		

A. PURPOSE OF PROGRAM

This program will design one or more rolled steel I-Beams, with or without cover plates, suitable for a given span, slab, beam spacing and live load.

B. PROGRAM SPECIFICATIONS

Written in COBOL

C. METHODS

D. EQUIPMENT DETAILS

Written for IBM 360/75

E. INPUT-OUTPUT

Any of the beam or plate sizes may be fixed to your own requirements, and you may designate a minimum beam height or size.
The output data includes beam size, plate size, stresses, weights, deflections, plate weld and shear stud spacing. The design moments and section values can also be obtained as an option.

F. ADDITIONAL REMARKS

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM		PROGRAM NO.	
Bridge Layout & Elevations		713-100	
PREPARING AGENCY			
North Carolina Division of Highways			
AUTHOR(S)	**DATE PROGRAM COMPLETED**	**STATUS OF PROGRAM**	
		PHASE	**STAGE**
Larry A. Colbert	January 1972		

A. PURPOSE OF PROGRAM

This program will run a variety of jobs associated with the layout and elevation of a bridge. It can also be used for other jobs such as retaining walls.

B. PROGRAM SPECIFICATIONS

Written in PL/1

C. METHODS

D. EQUIPMENT DETAILS

Written for IBM 360/75

E. INPUT-OUTPUT

The engineer may choose the input-output from simple grade-line elevations to a full bridge layout with chords, arcs, angles, slopes, elevations, etc.

F. ADDITIONAL REMARKS

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM Bar Schedule	**PROGRAM NO.** 713-110
PREPARING AGENCY North Carolina Division of Highways	

AUTHOR(S)	**DATE PROGRAM COMPLETED**	**STATUS OF PROGRAM** PHASE	STAGE
	January 1971		

A. PURPOSE OF PROGRAM

This program will compute bar weights and list the results in a format suitable for including in the plans.

B. PROGRAM SPECIFICATIONS

Written in PL/1

C. METHODS

D. EQUIPMENT DETAILS

Written for IBM 360/75

E. INPUT-OUTPUT

F. ADDITIONAL REMARKS

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM Box Culverts	PROGRAM NO. 713-090
PREPARING AGENCY North Carolina Division of Highways	

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STATUS OF PROGRAM: STAGE
Larry A. Colbert	January 1970		

A. PURPOSE OF PROGRAM

This program designs reinforced concrete box culverts.

B. PROGRAM SPECIFICATIONS

Written in PL/1

C. METHODS

The culverts are designed using formulae based on Hickersons method of moment distribution, with a variable "R" ratio. A fixed base condition is assumed, and the top half of the culvert is designed. The bottom half of the culvert is made the same. If there is no floor slab, then a half-fixed base condition is assumed.
The quadruple culvert is designed using the same moment distribution as for a triple culvert.

D. EQUIPMENT DETAILS

Written for IBM 360/75

E. INPUT-OUTPUT

This program will design a single or multiple box culvert, knowing the span, height, and fill. It will also give the bar schedule as an option, knowing the length and end skews.
The output includes thickness of slab and wall, concrete volume per foot, steel weight per foot, and bar details.

F. ADDITIONAL REMARKS

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM	PROGRAM NO.
The Analysis of Continuous Beams for Highway Bridges IV	713-120

PREPARING AGENCY

State Highway Department of Georgia

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STATUS OF PROGRAM: STAGE
Glenn H. Sikes			

A. PURPOSE OF PROGRAM

This program analyses continuous beams for highway bridges.

B. PROGRAM SPECIFICATIONS

The program was written in FORTRAN IV.

C. METHODS

Classical theories for the analysis of statically indeterminate structures are used. Simpson's method is used to evaluate the integrals required to compute the elastic properties of the beam and influence line areas. Moment-Area Theorems and Maxwell's Law of Reciprocal Deflections are used to compute deflections and influence lines for deflections. One-Cycle Moment Distribution is used for the distribution of fixed-end moments. For a detailed description of the Method of Solution, see Volume 1 of the write-up, "The Analysis of Continuous Beams for Highway Bridges," written for the IBM 360 computer.

D. EQUIPMENT DETAILS

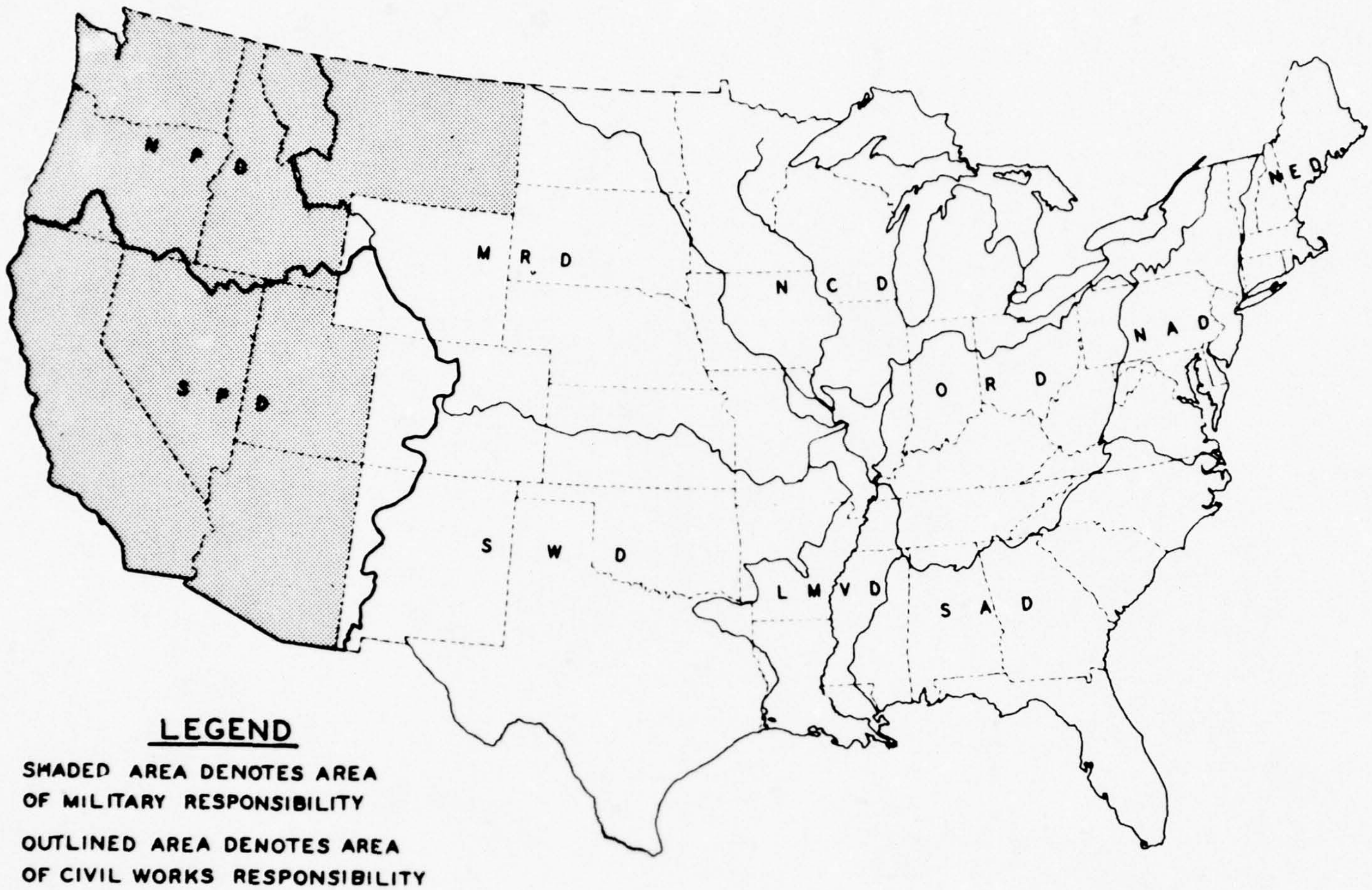
Core storage requirements are approximately 122,000 positions (bytes in the IBM 360).

E. INPUT-OUTPUT

This program performs the complete analysis of a continuous beam for a highway bridge and reports the moments, stresses, shears, reactions, deflections and shear connector spacings produced by the dead loads and the standard highway live loads (including the special military loading and the sidewalk live load) defined by the AASHTO "Standard Specifications for Highway Bridges," 1969, Interims 1970, 1971.

F. ADDITIONAL REMARKS The beam may be of concrete, steel or composite concrete-steel construction. The number of spans may vary from two to eight, with any combination of lengths. The minimum span length for accurate truck live load is fourteen feet. The program recognizes practically any type of variation of the cross section. Accuracy is well within that required for design. All possible live loading conditions are considered to insure that a maximum is obtained for each value under consideration. The program will not analyze a continuous beam that acts as a rigid frame with the substructure, nor a continuous beam with intermediate hinges.

SOUTH PACIFIC DIVISION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SHADED AREA DENOTES AREA OF MILITARY RESPONSIBILITY
OUTLINED AREA DENOTES AREA OF CIVIL WORKS RESPONSIBILITY

SOUTH PACIFIC DIVISION DESIGN AND CONSTRUCTION RESPONSIBILITIES AND COMPUTER USE REVIEW

by

James Tanouye*

Introduction

Following is a brief introduction to the SPD based in San Francisco. Our Division supervises both civil and military works. Geographically our civil works territory covers California, Nevada, Utah, and Arizona. The military works encompasses a larger area, including Washington, Oregon, Idaho, and Montana in addition to our civil works area. Our Division is comprised of San Francisco, Sacramento, and Los Angeles Districts.

Projects constructed in SPD include such diverse structures as our 620-ft-high rock-fill New Melones Dam which includes a 300-Mw powerhouse, military hospitals, hundreds of miles of flood control channels, harbors, and shore protection structures.

Use of Computers in SPD

The computer in structural engineering has been used to great advantage for the last 15 yr, especially for analysis and design of concrete channel walls and cut and cover conduits. As we became more aware of the machine's capabilities and especially with the training that our younger engineers have had with computers in the universities, we have expanded its use considerably.

In our civil works, our Districts have developed and used programs for steel tunnel liners, oblong conduits, bifurcation analysis, and many bridge girder and pier designs. In military works, our Sacramento District has analyzed structures, such as hangars and 3-D space trusses. The 3-D space truss study by Dan Reynolds, one of the moderators, was for a standard dental clinic with conventional framing.

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* Structural Engineer, South Pacific Division (SPD).

Realizing a substantial savings in the weight of steel using a space frame, we have submitted a Value Engineering (VE) proposal on this project. Since this standard drawing may be site adapted to several other Army installations, the savings can be multiplied many times over. This is a good example of how valuable a tool the computer can be in exploring new ideas. The 3-D space truss is very complicated to analyze; without the aid of the computer, anything other than conventional framing would not have been feasible.

The programmable calculator is effectively used for repetitious and relatively small calculations. PCA has many useful programs, such as flat slabs and ultimate strength design, which Sacramento District uses regularly.

With California located in earthquake country, we have been involved to varying degrees with several dynamic analysis studies. Prior to the development of any expertise in the area of earthquake engineering within the Districts, seismic analyses were carried out entirely by consultants. We've had two 10-story hospitals, two earth-fill dams and an existing concrete arch dam analyzed for dynamic loads. When dams in Zones 3 and 4 are to be analyzed under the Dam Safety program, we plan to have our own in-house expertise and computer programs ready to go.

Types of Services Used

Our Division has a G-437 and each of our Districts has a G-225. The use of the in-house computers is very limited. One reason is that we are fortunate to have access to the CDC 7600 at Lawrence Berkeley Laboratory at the University of California. This computer has been used for sometime now by our hydrologists. Recently, our structural engineers have made extensive use of this service with the advent of finite element codes.

Our Sacramento District has especially made good use of the finite element programs SAP IV and GENSAP in both military and civil works. Our Los Angeles District relies heavily on the use of INFONET in their design of channel walls and bridge girders. Also, their Construction

Division uses INFONET to run an independent rigid frame analysis to check shop drawing submittals for preengineered buildings.

Dissemination of Information in SPD

The Division Office does not coordinate the exchange nor the development of programs. Our survey showed that programs are not usually exchanged between Districts unless there is a need. As the need arises, the District will search other Districts or the U. S. Army Engineer Waterways Experiment Station Library. If the search is not successful, a program may be written in-house if time and money permit. To minimize duplications and to keep abreast, it would be helpful to have notices sent out monthly on new programs developed. This could be included in the monthly "Engineering Computer Notes," a publication which we find very informative. The exchange of programs with other Federal agencies such as BuRec, Navy, Tennessee Valley Authority, etc., would also minimize duplications.

Problem Areas

The unfamiliarity with computers is probably one of the biggest hang-ups to full use. With the constraints of meeting design deadlines and watching the design costs, there is little opportunity for experimenting and writing programs. Furthermore, with the technology explosion, all the different hardware and software options can be confusing. The difficulty with using the code is also a problem. For instance, coding input and interpreting output for SAP can be very time consuming.

Another problem identified in the Sacramento District is that one or two structural engineers become the "programming experts" and they are relied upon totally for computer work, thereby cutting their own design time. The expertise becomes concentrated in a few people. A more effective situation would be to have each engineer capable of computer use.

Suggestions for Improvements

To maximize the use of computers, it is imperative that a training and development program be implemented, as prescribed in ER 350-1-412. The objective, as stated in this regulation, is for all engineers and managers to complete some type of computer training course commensurate with their positions. This will remove the "mystery associated with computers" and provide the engineer with an "appreciation of the power and limitations associated with the actual operation of a computer." The engineer will be "persuaded to adopt a favorable position toward Automatic Data Processing (ADP) which should provide an environment in which computer applications are optimized." Familiarizing supervisory personnel is especially essential since they will either encourage or discourage its use. In VE, a full-time team travels the country teaching VE. A similar approach may be used for computer training. The Districts are less hesitant to send an engineer to a course in his own office than to one across the country. Computers are here to stay and should be an indispensable engineering aid.

Another thought worth considering for our Districts, if work load justifies, is to form a structural analyst section. This group will be responsible for computer analysis, developing programs, and keeping abreast of the state of technology. To keep from developing specialists, it would be necessary to rotate designers into the analyst section. This may seem an encroachment upon the ADP responsibilities, but the ADP usage consultant is skilled in making the equipment run; he may or may not be acquainted with the results obtained. On the other hand, the structural analyst must understand the basic concepts of the program. For instance, he must understand the formulation of the stiffness matrix and have a knowledge of finite element theory. In regards to computer equipment, it would be very desirable to have a large CDC computer at the disposal of all the Corps offices. With finite element programs, such as SAP IV, a large computer is almost a necessity. The BuRec has invested in a CDC system and they are very pleased.

Computer graphics are another invaluable aid to structural design;

the Corps should encourage their acquisition and use. This tool would eliminate a lot of unnecessary printouts and would minimize many hours of lost time due to errors in data preparation. The plotter can plot the geometry and typology of the structure for the designer to visually check the input and output.

SACREMENTO DISTRICT'S USE OF COMPUTERS WITH EMPHASIS ON FINITE ELEMENT

by

Robert Haavisto*

The Sacramento District has been using computers in the design of structures with increasing frequency since 1969. Our early applications were modest by today's standards. This is not surprising, since only a few engineers were familiar with computers and our in-house machine was an IBM 1620.

In the Civil Design Branch we were faced with some very tight design and construction scheduling for the outlet works contract for the New Melones Lake project. Engineers charged with performing the actual design were able to convince supervisors that time spent writing a computer program at the beginning of a design analysis could prove to be time well spent. We started design of the outlet works not knowing whether New Melones was to have a 150-Mw or a 300-Mw powerplant; power studies were not yet complete. We produced complete plans and specifications for outlet works for either size plant.

We wrote our own programs to analyze steel and concrete tunnel linings and the steel bifurcations for power, flood control-irrigation, and surge tank tunnels. These programs lacked the analytical and technical refinements we have come to expect, and demand, today. But we felt they had saved us from considerable overtime, had prevented more than a few slipped deadlines, and had improved the quality of the final product as well. A few of us had gotten our feet wet in the area of computer-aided design, and we enjoyed it. In 1970 we acquired our G-225, and by means of a contract courier service we had access to the G-437 at Division in San Francisco and CDC 6600/7600 complex at the Lawrence Berkeley Laboratory (LBL) in Berkeley, California.

Access to improved hardware led to expansion of our program library. We wrote our own programs as the need arose. For example, we

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* Structural Engineer, South Pacific Division (SPD).

developed programs to analyze and design concrete beams on elastic foundations and steel ring girder supports for penstocks. To aid testing and monitoring programs during and after construction, we wrote programs to reduce the data from SR-4 strain gages, Carlson strain meters, rock belt load cells, and pore pressure meters. We went to outside sources for "canned" programs such as that in the GE structural engineering package for retaining wall design, or the PCA programs for slab and column design. A few concerned engineers attended university courses and seminars dealing with advanced structural analysis techniques, such as matrix analysis, finite element methods, and structural dynamics. Through their efforts we added three good finite element programs and several stiffness and frame analysis programs to our library. By 1974 we had a COPE 1200 terminal, which, except for a few special circumstances, has replaced the courier service for processing jobs on the Division or LBL computers.

We have the finite element programs GENSAP, SAP IV, and NONSAP on the CDC 7600 at LBL. We've done considerable testing and experimenting with GENSAP and SAP IV to verify that they are indeed user-ready and to explore their capabilities. We are just beginning to investigate the nonlinear analysis program NONSAP. We've developed confidence in GENSAP and SAP IV and in our ability to use them effectively.

Dan Reynolds, the <u>only</u> computer user in the Military Design Branch in Sacramento, has used GENSAP and SAP IV to good advantage for several 2- and 3-dimensional frame analyses, often including shear wall and diaphragm effects.

We used GENSAP and SAP IV to analyze the tunnel plug and the surge tank for the New Melones project. SAP IV was used for stress analysis of four existing cut-and-cover conduits for a preliminary survey report for the Merced Stream Group project. SAP IV and GENSAP were used in the study of alternative concrete tunnel lining cross sections for the Lakeport Lake project. SAP IV was used to analyze a gate hoist frame at New Melones that had failed in service and was being redesigned. We're presently using SAP IV in the design analysis of alternative designs for the Camp Nine Road Bridge at New Melones, one a continuous steel plate

girder, the other a cast-in-place restressed concrete box girder. The Camp Nine Bridge has given us our first exposure to interactive time sharing. We recently acquired two time-share programs, from the Rock Island District, for stress analysis of plate girder bridge sections. In addition, Rock Island made us aware of a program, available on the North Pacific Division computer, which will analyze reinforced concrete members subjected to axial thrust and biaxial bending. We intend to use this program in the design of the piers for both bridges. Structural design for the upcoming Marysville Lake project will depend heavily on computers, particularly for finite element analyses, both static and dynamic.

The finite element method and the advent of the SAP-series programs, and, of course, our ability to access them at LBL, has had a definite positive impact on the way engineers in Civil Design Branch are coming to look on the computer as an important tool. Those of us who are familiar with and use the finite element programs regularly are often amused at the reaction of uninitiated designers when we advise them "Yes, SAP IV (or GENSAP) can do your 3-dimensional analysis, for almost any number and combination of load cases you desire, and provide you with reactions, deflections, stresses, and/or member forces, all in a single computer run." We've made converts of a couple of engineers in the past year, in one case by merely demonstrating several analysis options on test problems, in the other by "coming to the rescue" with the analysis of a highly indeterminate frame. In fact, we find ourselves acting more and more like in-house consultants as the capabilities of the computer become widely known around the branch. This situation is both gratifying and troublesome. Our own work often suffers, because it's hard to put off other engineers who ask "Can GENSAP do this?" or "Do we have a program to handle that?" Most often the answer is "Yes," and we usually become involved to varying degrees with the other fellow's problem.

The Sacramento District has come a long way since 1969, but much remains to be done if we are ever to become really effective computer users.

For example, the finite element method is an extremely powerful tool. It's not the answer to every problem, but it will certainly receive more consideration as our work load increases. We have an urgent need to augment our finite element programs with complete modern graphics capabilities. Displaying the finite element mesh and correcting any errors before executing the analysis will save time and money. We've had a number of runs, some of them relatively expensive, nullified by misplaced nodal points or erroneously specified boundary conditions. Graphical representation of displacements, moments, shears, and stresses will prevent misinterpretation and will permit results to be used more quickly and efficiently. Such refinements will not only benefit the few current users, but will make computer analysis more attractive to those who are "turned off" at the prospect of repeated corrections to card decks, or of digesting several inches of printer output.

Another pressing problem area involves the District program library. It's a mess. Those who are new to computer-aided design and are interested in seeing if perhaps a program exists which will meet their needs often come away discouraged. Few programs are documented, and then sometimes poorly. Abstracts are nonexistent; the latest library listing carries obsolete programs and omits recent additions and modifications. It has been the responsibility of the individual program author/user to document and maintain information on the programs with which he is involved. But this same individual is also the one responsible for producing design computations, contract drawings, and specifications. There is never enough time to properly attend the program library. Both Civil and Military Design Branches have had engineers designated as "ADP Coordinator," but this has always been a responsibility assumed in addition to regular duties. The Design Branch "ADP Coordinator" should be a full-time position.

A problem that has been with us since the advent of the computer is lack of encouragement, or even outright resistance, on the part of some supervisory personnel toward computer use. Many engineers admit they are reluctant to even consider a computer analysis for this reason. But there are many nonsupervisory personnel who fail to consider the

computer as a useful tool for reasons of their own, ranging from early unsuccessful encounters to lack of understanding and mistrust. These attitudes are difficult to understand when we can now point to many successful applications. To have to argue the value and validity of computer analysis for almost every new application is absurd and frustrating. Enlightened engineers, supervisory and nonsupervisory alike, are essential if we are to continue to make progress in computer-aided design.

Appendix A: Abstracts of South Pacific Division Structural Engineering Computer Programs

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM
SAP4 - Structural Analysis Program

PROGRAM NO.
713-F3-R0-012

PREPARING AGENCY U. S. Army Engineer Waterways Experiment Station, Automatic Data Processing Center, P. O. Box 631, Vicksburg, Mississippi 39180

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STATUS OF PROGRAM: STAGE
K. Bathe, E. Wilson, F. Peterson, Univ. Calif. Berkeley, California	June 1973	Complete	Final

A. PURPOSE OF PROGRAM

SAP4 was designed to be an effective and efficient computer program for analyzing very large complex 3-D structural systems; however, there is no loss in efficiency in the solution of small problems. Nine structural element types may be used in a static or dynamic analysis. In a dynamic analysis the options are: (1) frequency calculation; (2) frequency calculation followed by response time history analysis; (3) frequency calculation followed by response spectrum analysis; (4) response time history analysis by direct integration.

B. PROGRAM SPECIFICATIONS

Batch FORTRAN IV. (Array A is 8000) single precision.

C. METHODS

Finite element method of structural analysis.

D. EQUIPMENT DETAILS

Honeywell G-635, 54K (36-bit word) memory, card reader, printer, disc or tape for temporary storage.

E. INPUT-OUTPUT

Input - Nodal point data may be in cartesian (x,y,z) or cylindrical (r,z,θ) coordinates. Boundary conditions are defined for each node. Element data include material properties such as Young's Modulus, Poisson's ratio and weight density. Nodal and element loads may be input. Dynamic input includes ground acceleration, time-varying loads and damping coefficient.

Output - Static output is nodal displacement and translation. Element output includes axial stress and force, shear moment, stress and torque. Cynamic output is structural modes and frequencies (eigenvalue/eigenvector) with selected nodal displacement and element stress components.

F. ADDITIONAL REMARKS

Report available: "A Structural Analysis Program for Static and Dynamic Response of Linear Systems" - K. Bathe, E. Wilson, F. Peterson. EERC 73-11 June 1973: U. of California, Berkeley, California
Contact: W. L. Boyt (WES) 601-636-3507 ADPC

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM: NONSAP - A Structural Analysis Program for Static and Dynamic Response of Nonlinear Systems		PROGRAM NO.
PREPARING AGENCY: Structural Engineering Laboratory - University of California - Berkeley		
AUTHOR(S): Bathe, Klaus-Jurgen; Wilson, Edward L.; Iding, Robert H.	DATE PROGRAM COMPLETED: Feb. 1974	STATUS OF PROGRAM: PHASE: I; STAGE: Complete

A. PURPOSE OF PROGRAM

The nonlinear analysis program NONSAP presented in this report is not an extension of the linear analysis program SAP IV, but rather a completely new development. Program NONSAP is designed with two primary objectives. The first aim is the efficient solution of a variety of practical nonlinear problems with the current capabilities of nonlinear analysis procedures and computer equipment. The second objective is to have a program which can be used effectively in the various research areas pertaining to non-linear analysis. Because of continuous improvements in (continued)

B. PROGRAM SPECIFICATIONS

Batch FORTRAN IV.

C. METHODS

The main phase in the analysis is the step-to-step solution of the equilibrium equations. There are four different analysis types: linear static, linear dynamic, nonlinear static, and nonlinear dynamic.
Although NONSAP can be a very powerful analysis tool, it should be realized that depending on the problem considered, the program may not be easy to use and, for example, much more difficult to handle than the linear analysis program SAP IV. The use of NONSAP requires a thorough (continued)

D. EQUIPMENT DETAILS

CDC/1400, card reader, printer, disc or tape for temporary storage.

E. INPUT-OUTPUT

The structural systems to be analyzed may be composed of combinations of a number of different finite elements. The program presently contains the following element types: (a) three-dimensional truss element, (b) two-dimensional plane stress and plane strain element, (c) two-dimensional axisymmetric shell or solid element, (d) three-dimensional solid element, and (e) three-dimensional thick shell element. (continued)

F. ADDITIONAL REMARKS

A. PURPOSE OF PROGRAM - (continued)

nonlinear analysis procedure, both objectives are attained sumultaneously by the development of an efficient, modular, and easily modifiable general analysis code. The program is designed for a general incremental solution of nonlinear problems, but naturally can also be used for linear analysis.

C. METHODS - (continued)

understanding of the theoretical basis of the program, of the numerical techniques employed and their computer implementation. This is particularly the case because not many nonlinear solutions are yet possible on a routine basis. Therefore, it is necessary to apply the program only under the conditions and assumptions for which it was developed.
With regard to future developments of NONSAP, the program has primarily been developed to be used as a tool for further research in analysis techniques, nonlinear formulations and the characterization of nonlinear materials. There fore, additional developments are expected to be oriented towards applied research in those areas.

E. INPUT-OUTPUT - (continued)

The nonlinearities may be due to large displacements, large strains, and nonlinear material behavior. The material descriptions presently available are: for the truss elements, (a) linear elastic and (b) nonlinear elastic; for the two-dimensional elements, (a) isotropic linear elastic, (b) orthotropic linear elastic, (c) Mooney-Rivlin material, (d) elastic-plastic materials, von Mises or Drucker-Prager yield conditions, (e) variable tangent moduli model, and (f) curve description model (with tension cut-off); and for the three-dimensional elements, (a) isotropic linear elastic and (b) curve description model.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM General Elastic and Nonlinear Structural Analysis Program (GENSAP)

PROGRAM NO. 713-C8-70-06F

PREPARING AGENCY
U. S. Army Engineer Division, Huntsville

AUTHOR(S) See reverse

DATE PROGRAM COMPLETED June 1973

STATUS OF PROGRAM PHASE | STAGE

A. PURPOSE OF PROGRAM

GENSAP is a general purpose system for three-dimensional analysis of structural systems using the finite element approach.

B. PROGRAM SPECIFICATIONS

The system is comprised of three separate computer codes, PRESAP, RSPNSE, and SAPOUT, each code having a stand-alone capability. The codes are written in FORTRAN IV and can be readily adapted to suit any computer capable of running FORTRAN IV. However, the capacity and efficiency of the programs is greatly enhanced through the use of large-scale machines.

C. METHODS

The PRESAP and RSPNSE codes are based on the SAP (Structural Analysis Program) which was developed in 1969 and 1970 by Professor E. L. Wilson, University of California, Berkeley. Significant features are modal extraction by an approximate Rayleigh-Ritz method and linear/nonlinear analyses by the step-by-step integration method.

D. EQUIPMENT DETAILS

The configuration required for this version of the current system includes a CDC 6400 mainframe, card reader, line printer, on-line mass storage (capable of ten logical assignments), two magnetic tape drives, and a plotter.

E. INPUT-OUTPUT

Input to PRESAP is via the card reader and includes such things as a description of the finite mesh model, loads, material properties, etc. Output from PRESAP includes printouts of the input data, the new renumbered mesh (if desired), and requested mode shapes and frequencies; plots of the original and new mesh and eigenvector plots; and restart tapes. Input to RSPNSE is via magnetic tape (from PRESAP) and punched card (for dynamic loading). (continued)

F. ADDITIONAL REMARKS

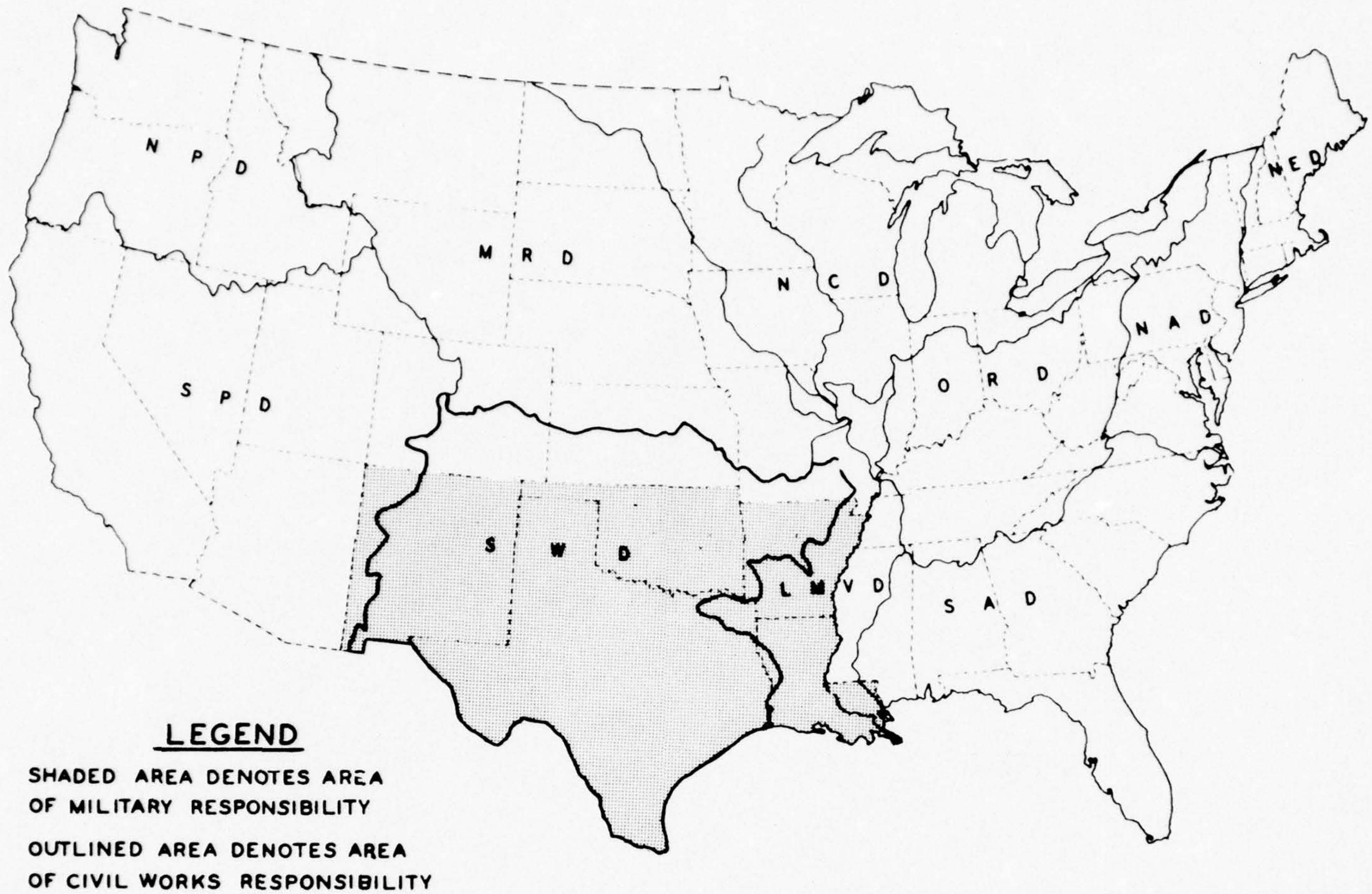
These codes have been successfully executed on Univac 1108 and CDC/6600-6400 computers.

AUTHOR(S): Agbabian Associates, 250 North Nash Street, El Segundo, California 90245. Code has been used extensively by the Huntsville Division.

E. INPUT-OUTPUT (Cont)

Output from RSPNSE includes, among other things, printouts of displacements, rotations, time histories, stresses, restart tapes, and a tape of saved time history data for SAPOUT. Input to SAPOUT is via magnetic tape (from RSPNSE) and the card reader. Output from SAPOUT includes listings and plots of motion and stress time histories, punched cards, and plots of response shock spectra.

SOUTHWESTERN DIVISION


N P D
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LEGEND
SHADED AREA DENOTES AREA
OF MILITARY RESPONSIBILITY
OUTLINED AREA DENOTES AREA
OF CIVIL WORKS RESPONSIBILITY

USE OF COMPUTERS IN STRUCTURAL DESIGN/ANALYSIS WORK IN THE SOUTHWESTERN DIVISION

by

C. F. Berryhill*

Southwestern Division Geographical Boundaries

The civil project boundaries are on watershed lines. In general they cover most of the States of Texas, New Mexico, Oklahoma, and Arkansas with some small portion of southern Colorado and Kansas.

The military project boundary surrounds the States of Texas, New Mexico, Oklahoma, Arkansas, and Louisiana.

SWD Districts

The Division is divided into 5 Districts. Albuquerque, Fort Worth, Galveston, Little Rock and Tulsa.

Albuquerque's projects include multipurpose reservoirs, such as Abiquiu, Jemez, John Martin, Conchas, Trinidad, Cochiti, and Los Esteros. Local flood protection projects include El Paso, Las Cruces, Dodge City, and Albuquerque.

Fort Worth's multipurpose reservoir projects include Whitney, Sam Rayburn, Amistad, Belton, Laneport, North Fork, Canyon, Lavon, and many others. Local flood protection projects include Dallas, Fort Worth, and San Antonio. Fort Worth has the entire Military Program for the SWD as well as civil projects for a large portion of North-Central Texas. The District covers 36 military installations in five states.

Galveston District is mainly concerned with Gulf Coast Hurricane Flood Protection structures. These include projects at Texas City, Port Arthur, and Freeport. Galveston is also noted for its work on the Gulf Intercoastal Waterway, the Houston Ship Channel, and the smaller navigation channels along the Gulf coast.

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* Chief, Structural Section, Southwestern Division (SWD).

Little Rock District designed and constructed the lower portion of the Arkansas River Multipurpose Project, Lock and Dam No. 1 through 13, including Dardanelle and Ozark. Multipurpose reservoir projects include Norfork, Bull Shoals, Table Rock, Greers Ferry, and Beaver.

Tulsa District designed and constructed the upper portion of the Arkansas River Multipurpose Project from Lock and Dam No. 14 through 18, including Webbers Falls and Robert S. Kerr. Other Arkansas River tributary dams include Keystone, Eufaula, Fort Gibson, Tenkiller Ferry, Kaw, John Redmond, Broken Bow, Fall River, and many others.

SWD Workload

Civil projects for FY 75 totalled approximately $120 million. Military expenditures for FY 75 were approximately $240 million, and Civil E&D came to $22 million for FY 75. Seventy-five percent of the civil work was hired labor, compared to 25 percent for military projects. The remainder was contracted out to A-E Firms.

SWD Standard Programs

Prior to 1967, Districts worked more or less independently in writing programs. The computers in use then were the Bendix G-15 or IBM 1620. Many Districts had similar programs for design of tainter gates and conduits. There was a good deal of wasted effort involved in writing all these similar programs. Some Districts in SWD were not aware of other district programs.

In 1967 it became apparent that, if the Districts would cooperate in the development of needed structural programs, it would benefit all Districts in terms of time and money. SWDR 37-1-7 was issued setting up a standardization procedure.

A District is either assigned a topic for a program or volunteers one. By whatever process the District considers sufficient, it assembles the criteria and engineering assumptions, writes the program, and documents it.

The draft documentation is circulated to the other SWD Districts for review and comment. SWD adds its comments on the program and on the other Districts' comments and sends the package back to the originating District for resolution.

The originating District circulates its resolution of comments to the other Districts for further comment. When everyone is satisfied, the final documentation is published and the program cannot be altered until all Districts agree to the changes.

The Division Office prorates the originating Districts' costs, for reimbursement by the other Districts. This reimbursement is prorated according to SWD's estimate of each District's expected usage of the program.

There are limitations of SWD standardization process. With voluntary participation, it gets very low priority in manpower allocation in the District Offices. There is no control over programs that the author does not want to submit. In some cases the author does not want to spend the time and/or money to prepare the required documentation. In others, the author may want to retain the ability to edit his program as he sees fit.

The following programs are considered SWD standards. They are all written in FORTRAN and are on file at WES.

Program No.	Title	WES Time Share Symbol	Computer Written for	Computer Adapted for	Year
713-G1-M010	Tainter Gate Loads and Reactions	TGRA	G-225	G-635	1968
713-G1-M020	Two-Girder Gate Interior Rib	TGIN			
713-G1-M030	Tainter Gate External Rib Analysis	TGEX			
713-G1-M040	Tainter Gate Rigid Frame Analysis	TGRF			
713-G1-M050	Overflow Stability Analysis	TGØF			
713-G1-M060	Nonoverflow Stability Analysis	TGNF			
713-G1-M070	Four-Girder Gate Interior Rib	TGIN			
713-G1-M080	Three-Girder Gate Interior Rib	TGIN			
713-G1-M090	Ultimate Strength Analysis of Conduit	--		--	1970
713-F5-A1040	G-Frame	G-Frame	--	G-437	1969
713-G1-M5300	Retaining Wall Analysis and Plot	--	G-225	--	1967
713-G1-E0010	Concrete General Flexure Analysis	CGFA		G-635	1967
713-G1-M3170	Round Data Generator for Above	CGFARD		G-635	1967
713-G1-M3180	POSMO (Used with G-Frame)	--		--	1972
713-F3-M3510	SKNPL	SKNPL		G-635	1969

Of these fifteen programs, nine were written by the Tulsa District, one by Memphis, one by Seattle, one by Albuquerque, and three by the Galveston District. Six of the programs are used to design tainter gates, two-, three-, or four-girder types. The program, "G-Frame," was written by the Memphis District and can be substituted for the Tainter Gate Program, "Tainter Gate Rigid Frame Analysis," with similar results. SKNPL is similar to the Tainter Gate Rib programs but will also select a minimum cost rib. The conduit program, 713-G1-M090, bases the allowable ultimate shear on the ACI formula $Vc = 3.5\phi \sqrt{fc(1 + 0.002N/Ag)}$. This will give more conservative results than working stress design; therefore, the shear safety factor should be neglected for circular or oblong conduits and only the investigation mode used. The conduit program has been heavily used by several Districts. The retaining wall program is for a reinforced concrete cantilever wall. It computes overturning and sliding stability, computes moments, shears, and reinforcing required, and also plots the design memorandum plate with all the required information. The overflow and nonoverflow monolith programs are similar to the retaining wall program; they compute overturning, sliding stability, and base pressures. "Concrete General Flexure Analysis," of course, is well known and has been around for some time.

These programs are not elegant, that is, the method of analysis was whatever the structural engineer was using at the time in performing longhand computations. The intent was to merely relieve the engineer from doing these tedious hand calculations. These programs have not been corrected for later editions of AISC and ACI. However, we feel that the effect of code changes on these programs is minor. These programs have not been used as much as they should be by the Districts. The conduit program has received the most use.

SWD exercises only nominal control over computer programs. Division Regulation SWDR 18-1-1 goes into more detail in the use of computers. It includes the requirement that Districts not develop programs without informing SWD in order to avoid wasting time on programs already developed or in the process by others.

Proposed SWD Standard Program

The following program will be considered standard after District reviews are complete:

Program No.	Title	WES Time Share Symbol	Computer Written for	Computer Adapted for	Year
713-G9-M2064	EPVKSI	EPVKSI	G-225	G-635	1973

This program is used in the analysis of U-frame structures. It computes wall shears and moments and base slab shears and moments for uniform base pressure and for a base pressure higher than uniform under the wall and lower than uniform under the slab. This is a simple program which can be used for preliminary design of U-frame locks and final design of smaller U-frame structures, such as approach walls or stilling basins for outlet works. Wall friction is neglected in the program and must be added manually.

SWD Approved Programs

The following ten programs have been reviewed by SWD and approved for use. The results of these programs are accepted in lieu of submission of longhand computations.

Program No.	Title	WES Time Share Symbol	Type Computer	Adapted for	Year
713-G1-F401E	Analysis of Space Truss by Direct Stiffness	Corps	--	G-437	1971
713-F-401A	Direct Stiffness Analysis of Beams		--		1968
713-F-401B	Plane Pin Joint Truss by Direct Stiffness Method		--		
713-F-401C	Plane Frame Analysis by DSM		--		
713-F-401D	Analysis of Grid Structures by DSM		--		
713-L-3002	Analysis of Two Dimension Space Frame Structures		--		--
PCA-033	Analysis and Design Simple Span Precast Prestressed Railway and Highway Bridges	PCABR	IBM1130	G-225 remote terminal to G-635 WES	1969
713-F3-M3500	MDCF	--	--	G-635	--
713-F3-A2-580	Cantilever Pile Retaining Wall	K29035	--	G-635	1974
741-F3-A2-370	Cantilever Pile Retaining Wall	K71003	--	G-635	1974
713-G1-413A	3D Pile Analysis	--	G-225	--	--
	Phi Batter	--	--	--	1963
	Beta Batter	--	--	--	--

Six of these programs are the so-called "Stiffness Package" by Mr. Ashton of the Rock Island District. Many of us have had instructions in the use of these programs and they are on WES time share. MDCF, of course, is a WES program which computes moment distribution coefficients for prismatic members for a variety of loading conditions. Two programs by the New Orleans District, on cantilever pile retaining walls, are included. These programs will also analyze tieback walls. The PCA Program, "Analysis and Design of Simple Span Precast Prestressed Railway and Highway Bridges," is also in the WES Library. The 3D Pile Analysis program was originally written for the Arkansas River Navigation Project by the Little Rock District. It allows three directions of loading on batter and/or vertical piles in a two-dimensional layout. It uses the Hrennikoff method and assumes a fixed base and a constant elevation.

District Programs

In addition to the above programs, the Districts use others which they have either written or adapted and use frequently in routine work. Some of these programs are very good. These programs are listed in the appendix.

The Districts and Division have access to other structural programs listed in the time share libraries of the various time share services listed in the following paragraphs.

SWD Hardware

SWD has available for engineering use a G-437, two Terminet 300 Teletype terminals, and a Cope 1200 terminal. Tne terminals can access WES, MCAUTO, United Computing Systems (UCS), INFONET, Berkley, Control Data Corporation, and any Corps 400 computer.

District Hardware Available for Engineering Use

Fort Worth has a G-225, a Calcomp 750/563 off-line plotter,

12 Teletype terminals, 4 Western Union EDT's, 1 Texas Instruments terminal, and 1 Memorex 1280. The terminals can access WES, MCAUTO, UCS, RAMUS, and SWD's G-437. Fort Worth also has a Cope 1200 terminal which can access all these sources except RAMUS.

Tulsa has a G-225, a Calcomp 750/563 off-line plotter, 5 Teletype terminals, and a Cope 1200 terminal. The terminals can access INFONET, the G-437, Berkley, and UCS.

Galveston has a G-225, a Calcomp 570/563 off-line plotter, a Teletype terminal, and a Cope 1200 terminal. Access sources for these terminals are WES, the G-437, INFONET, Berkley, and UCS.

Albuquerque has a G-225 and two Teletype terminals which can access WES and the G-437.

Little Rock has a G-225, a Calcomp 760/563 off-line plotter, and 2 Teletype terminals which can access WES, MCAUTO, INFONET, Berkley, UCS, and the Division G-437. Due to use of "COEMIS" the Division G-437 and some of the Districts' G-225's are not free to run engineering problems at all times.

Dissemination of ADP Information to Districts

With regard to information on new programs, errors discovered in old programs, programs recently converted to time share or the G-437, etc., SWD, by means of multiple letters to the Districts, attempts to keep District structural people informed as to what is going on in regard to structural programs. Most of these letters also urge development of more computer programs in general and greater usage of existing programs.

Future Computer Usage

Within the next 5 years, we hope to (a) get most of the tedious structural computations for usual everyday type structures such as retaining walls, tainter gates, box culverts, conduits, gravity structures, bridges, U-frame structures, and building frames done by computer; (b) improve the programs for better methods of analysis, update for new

codes and specifications, and rewrite for the newer computers to use the additional storage capacity and faster running time; (c) get time share terminals in the District structural sections or close enough that they are readily accessible; (d) get the Districts to write more programs; and (e) be able to analyze structures by finite element more readily. We would like to write or get from others programs for (a) analysis of multicell wet well outlet works tower, (b) a good floodwall program using criteria in EC 1110-2-156, and (c) seismic design of buildings in accordance with TM 5-809-10.

It's not too clear, at present, how all of this might be done. Presumably the Districts will still be under manpower quotas or space limitations which will make it difficult to spare technical personnel from the everyday work load long enough to improve or write programs. Every day we see more and more of our Civil Works program given to Architect-Engineers due to the shortage of technical people in most Districts. It would appear that the only way we are going to come close to accomplishing our computer program objectives is to contract this work to WES or private firms.

Conclusion

I would like to see, as a result of this conference, a list of the Corps' best programs published and sent to all Corps offices. However, if Districts are familiar with other programs now that give good results they should be allowed to continue with them.

Districts should be required to make every reasonable use of available computer programs.

Appendix A: District Program Lists

District Programs

a. Albuquerque

Program No.	Title	Written for Computer	Computer Adapted for	Year
713-G1-M1070	Indeterminate Frame Analysis	IBM 1620	G-225/437	1974
713-J2-M1010	Flexible Culvert Pipe-Arch Analysis	IBM 1620	G-225	1972
713-G2-L3003	Retaining Wall	G-225	G-437	1971
713-J2-M0122	Beam on Elastic Foundation	G-225		1959
713-K5-G3020	Analysis of Continuous Beams for Highway Bridges	IBM 360	IBM 1620	1971

Indeterminate Frame Analysis covers the design of simple frame one-, two-, or three-cell culverts in accordance with 1971 ACI code and University of Illinois Bulletin 164. The program "Analysis of Flexible Culvert Pipe-Arch" uses the compression ring theory to compute seam strength, soil pressures, and gauge of pipe required. The Retaining Wall program is a San Francisco District program which investigates a given section, computes the reinforcing required using working stress design, and finds the most economical base width. "Beam on Elastic Foundation" is a program that computes slab moments, deflections, and base pressures using the method developed by Hetenyi. The program "Analysis of Continuous Highway Bridge IV" is a program developed by the Georgia Highway Department that will analyze from two to eight spans, in any material, using the 1971 AASHTO. It computes moments, shears, stresses, reactions, and deflections.

b. Little Rock

Program No.	Title	Computer	Originating District	Year
713-G1-C508	Two Column Bent for Hiway Bridge	G-225	Savannah	1970

This program computes column data due to wind load, dead load, and live load cases furnished by input. It also computes moments, shears, and reactions for cap and columns by moment distribution procedures.

c. Forth Worth

Program Description	WES T/S Symbol	Year
Analysis of 2 or 3 dimensional elast. statically loaded structure (SPSTRESS)	SPSTRESS	
Grid-beam and plate problems	BEAMWALK	
Generates interaction data for steel columns subject to biaxial bending and axial loads	SCIDI	
Computes geometric properties of any composite X-section	ESPRØP	1972
Analyzes continuous beams on elastic foundation	BMCØL3	1970
Modification of BMCØL3 data files	Change	
T/S version of 713-F5-A1040	GFRAME	
T/S version of 713-G1-M0090	ULTCØND	
Modification of GFRAME to find point of zero shear	GFRTRJ	

The Fort Worth District Structural Section has a teletype terminal and uses this for most computer problems. The above programs are not too well documented yet and there are no abstracts except for the standard program. EPVKSI has been mentioned above for possible inclusion as a standard SWD program. GFRAME and ULTCØND are standard programs. SPSTRESS performs a linear analysis of two or three dimensional elastic statically loaded structures with pinned or rigid joints. This program is on UCS time-share. BEAMWALK is a version of "A General Method for Solving Grid-Beam and Plate Problems" by R. L. Tucker, University of Texas. SCIDI generates interaction data for steel columns subjected to biaxial bending and axial loads. ESPRØP computes the geometric properties of any composite cross-section. BMCØL3 analyzes continuous beams on elastic foundation by a finite difference approach using a recursion method for solving systems of equations. This program is by R. L. Tucker of Arlington State College.

Appendix B: Abstracts of Southwestern Division Standard Programs

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.
Tainter Gate Loads and Reactions			713-G1-M0010
PREPARING AGENCY			
U. S. Army Corps of Engineers, Tulsa District, Tulsa, Oklahoma			
AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STAGE
Dean B. Englund	October 1968	Init	Op

A. PURPOSE OF PROGRAM

This program computes the sill location and slope, the dead load sill reactions, the dead load trunnion reactions, the wave loads, the wave load trunnion reactions, the trunnion reactions due to impact loading, and the trunnion reactions due to hydrostatic load. The cable pull, angle of pull, the location and length of contace and reactions due to cable pull (including friction) are given for both an overwound and underwound hoist. A summation of the trunnion reactions for various cases is also produced.

B. PROGRAM SPECIFICATIONS

This program is written in CARD FORTRAN.

C. METHODS

All forces are statically determinate.

D. EQUIPMENT DETAILS

The equipment required is the GE-225 central processor (8K memory) with a card reader and a high speed printer.

E. INPUT-OUTPUT

Input is by cards.
Output is on printer paper.

F. ADDITIONAL REMARKS

None.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.
Two Girder Tainter Gate Interior Rib Analysis			713-G1-M0020
PREPARING AGENCY			
U. S. Army Corps of Engineers, Tulsa District, Tulsa, Oklahoma			
AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STAGE
Dean B. Englund	October 1968	Init	Op

A. PURPOSE OF PROGRAM

This program computes for a two-girder tainter gate, the optimum girder spacing and the moments, shears and reactions of the interior ribs.

B. PROGRAM SPECIFICATIONS

The program is written in CARD FORTRAN.

C. METHODS

The rib with two supports is statically determinate. The computed girder spacing is that spacing which will produce equal maximum positive and negative moments.

D. EQUIPMENT DETAILS

The equipment required is the GE-225 central processor (8K memory) with a card reader and a high speed printer.

E. INPUT-OUTPUT

Input is by cards.
Output is on printer paper.

F. ADDITIONAL REMARKS

None.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.
Tainter Gate Exterior Rib Analysis			713-G1-M0030
PREPARING AGENCY			
U. S. Army Corps of Engineers, Tulsa District, Tulsa, Oklahoma			
AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM — PHASE	STATUS OF PROGRAM — STAGE
Dean B. Englund	October 1968	Init	Op

A. PURPOSE OF PROGRAM

This program computes the moments, shears and reactions for the exterior rib of a 2, 3, or 4 girder tainter gate under normal and stall torque cable tension.

B. PROGRAM SPECIFICATIONS

This program is written in CARD FORTRAN.

C. METHODS

Slope deflection equations are used to compute the moments over the supports for the 3 and 4 girder analysis. Positive moments, shears and reactions are found from free body diagrams. The 2 girder analysis is statically determinate.

D. EQUIPMENT DETAILS

The equipment required is the GE-225 central processor (8K storage) with a card reader and a high speed printer.

E. INPUT-OUTPUT

Input is by cards.
Output is on printer paper.

F. ADDITIONAL REMARKS

None.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM Tainter Gate Rigid Frame Analysis			**PROGRAM NO.** 713-G1-M0040
PREPARING AGENCY U. S. Army Corps of Engineers, Tulsa District, Tulsa, Oklahoma			
AUTHOR(S) Dean B. Englund	**DATE PROGRAM COMPLETED** October 1968	**STATUS OF PROGRAM** — **PHASE** Init	**STAGE** Op

A. PURPOSE OF PROGRAM

This program computes the moments, reactions, axial loads and unit stresses for a tainter gate frame comprised of 1 girder and 2 struts.

B. PROGRAM SPECIFICATIONS

This program is written in CARD FORTRAN.

C. METHODS

The moments reactions and axial forces are computed by the use of slope deflection equations and free body diagrams. The unit stresses are computed according to EM-1110-1-2102, "Working Stresses for Structural Design" and the Sixth Edition of the "Steel Construction Manual."

D. EQUIPMENT DETAILS

The equipment required is the GE-225 central processor (8K storage) with a card reader and a high speed printer.

E. INPUT-OUTPUT

Input is by cards.
Output is on printer paper.

F. ADDITIONAL REMARKS

None.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM Overflow Stability Analysis	PROGRAM NO. 713-G1-M0050

PREPARING AGENCY
U. S. Army Corps of Engineers, Tulsa District, Tulsa, Oklahoma

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STATUS OF PROGRAM: STAGE
Dean B. Englund	October 1968	Init	Op

A. PURPOSE OF PROGRAM

This program computes the uplift pressures, the horizontal thrust, the crest pressure, the bucket forces, the resistances to sliding and the base pressures for a controlled or uncontrolled ogee weir monolith.

B. PROGRAM SPECIFICATIONS

The program is written in CARD FORTRAN.

C. METHODS

The method of computation follows the criteria set forth in EM-1110-2-2400, "Structural Design of Spillways and Outlet Works" dated November 2, 1964 and EM-1110-2-2200, "Gravity Dam Design."

D. EQUIPMENT DETAILS

The equipment required is the GE-225 central processor (8K memory) with a card reader, a magnetic tape subsystem with 2 tape handlers and a high-speed printer.

E. INPUT-OUTPUT

Input is by cards.
Output is on printer paper.

F. ADDITIONAL REMARKS

None.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.
Non-overflow Stability Analysis			713-G1-M0060
PREPARING AGENCY			
U. S. Army Corps of Engineers, Tulsa District, Tulsa, Oklahoma			
AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STAGE
F. Webster G. Henson	October 1968	Init	Op

A. PURPOSE OF PROGRAM

This program computes the information necessary to analyze the stability of a non-overflow section.

B. PROGRAM SPECIFICATIONS

The program is written in CARD FORTRAN.

C. METHODS

Moments of forces applied to the structure were taken about the moment center shown on plate No. 1. Forces applied in the analysis are dead load, external water pressure, earth pressure and uplift.

D. EQUIPMENT DETAILS

The equipment required is the GE-225 data processing system (16K storage) with GE card reader, 3 tape handlers, and GE high-speed printer.

E. INPUT-OUTPUT

Input is by cards.
Output is on printer paper.

F. ADDITIONAL REMARKS

The input variables SX, SY, SKX, and SKY are scale factor for the plotter. These variables are to be ignored until the program is further developed to make use of the plotter.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.
Four-Girder Tainter Gate Interior Rib Analysis			713-G1-M0070
PREPARING AGENCY			
U. S. Army Corps of Engineers, Tulsa District, Tulsa, Oklahoma			
AUTHOR(S)	**DATE PROGRAM COMPLETED**	**STATUS OF PROGRAM** — PHASE	STAGE
Dean B. Englund	October 1968	Init	Op

A. PURPOSE OF PROGRAM

This program computes for a four-girder tainter gate, the optimum girder spacing and the moments, shears and reactions of the interior ribs.

B. PROGRAM SPECIFICATIONS

The program is written in CARD FORTRAN.

C. METHODS

The rib is analyzed by the use of slope deflection equations. The computed girder spacing is that spacing which will produce equal maximum negative moments.

D. EQUIPMENT DETAILS

The equipment required is the GE-225 central processor (8K memory) with a card reader and a high-speed printer.

E. INPUT-OUTPUT

Input is by cards.
Output is on printer paper.

F. ADDITIONAL REMARKS

None.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM	PROGRAM NO.
Three-Girder Tainter Gate Interior Rib Analysis	713-G1-M0080

PREPARING AGENCY
U. S. Army Corps of Engineers, Tulsa District, Tulsa, Oklahoma

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STATUS OF PROGRAM: STAGE
Dean B. Englund	October 1968	Init	Op

A. PURPOSE OF PROGRAM

This program computes for a three-girder tainter gate, the optimum girder spacing and the moments, shears and reactions of the interior rib.

B. PROGRAM SPECIFICATIONS

This program is written in CARD FORTRAN.

C. METHODS

The rib is analyzed by the use of slope deflection equations. The computed girder spacing is that spacing which will produce equal maximum negative moments.

D. EQUIPMENT DETAILS

The equipment required is the GE-225 central processor (8K memory) with a card reader and a high-speed printer.

E. INPUT-OUTPUT

Input is by cards.
Output is on printer paper.

F. ADDITIONAL REMARKS

None.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM Ultimate-Strength Analysis or Design of Variable Section Conduit	PROGRAM NO. 713-G1-M0090
PREPARING AGENCY U. S. Army Engineer District, Albuquerque	

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STAGE
Charles A. Rich, CPT, CE Gerald C. Romero	April 1971	Final	

A. PURPOSE OF PROGRAM

This program computes moments, thrusts, shears, and factors of safety in shear and combined axial load and flexure in single-barrel reinforced concrete conduits under high fills.

B. PROGRAM SPECIFICATIONS

The program was initially coded in PDQ FORTRAN (a modified version of basic IBM 1620 FORTRAN), and was later converted to GE 225 CARD FORTRAN. Both source listings are included in the ADDENDA to Section III.

C. METHODS

The factors of safety are calculated using ultimate-strength criteria outlined in ACI Standard Building Code Requirements for Reinforced Concrete (ACI 318-63). The program consists of a Geometry Phase; a Load-Determination Phase; a Moment Thrust, and Shear Calculation Phase; and an Ultimate Strength Phase.

D. EQUIPMENT DETAILS

The program may be run on an IBM 1620 computer with 40,000 digits of core storage, or on a GE 225 system with 8,000 words (24,000 characters) of memory. The GE 225 program can probably be used on other machines of equivalent capacity with little or no modification of the source statements.

E. INPUT-OUTPUT

Only the basic I/O devices (card reader and printer, or console typewriter on the IBM 1620) are needed. No magnetic tape units, special features, or optional hardware items are required.

F. ADDITIONAL REMARKS

None.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM	PROGRAM NO.
GFRAME	713-F5-A1040

PREPARING AGENCY
Memphis District Corps of Engineers

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STAGE
Robert E. Brittain Converted by C. E. Word	13 Oct 69 converted to 225 10 Apr 72 and to 437 9 Aug 72		

A. PURPOSE OF PROGRAM

This program solves for joint translation and rotations and member shears, moments and axial loads for rigid frames with up to 60 members and 30 joints. Each member may be loaded with up to 4 point loads which may be skewed and a uniformly varying distrubuted load across the member. Joints may have externally applied forces and moments. No member releases are possible. Supports may be roller, hinge, or fixed.

B. PROGRAM SPECIFICATIONS

GE 437
FORTRAN IV

4 external subroutines

No switches

C. METHODS

Obtain detailed writeup from: ADP Coordinator
Memphis District
Corps of Engineers

Matrix analysis solution: Clinton E. Word
FTS Telephone 713-763-1429
Galveston, Texas

D. EQUIPMENT DETAILS

GE 437
Card reader
Printer
Punch (POSMO)

E. INPUT-OUTPUT

Input-Structure geometry, joint fixity, and loading
Output-Joint displacements, structure reactions, and member and forces and moments
Optional Output-Complete input card deck for Program POSMO, 713-G1-M3180, for A,V,M at 1/10 points of each member.

F. ADDITIONAL REMARKS

1. Program GFRAME is in the Waterways Experiment Station time-sharing computer on-line library.
2. Sign convention in input and output is right-hand rule cartesian. Angles are in degrees.
3. Program POSMO, 713-G1-M3180 can be otained from the Galveston District Corps of Engineers.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.
Wall Stability Analysis and Plot			713-G1-M5300
PREPARING AGENCY			
Tulsa District, Corps of Engineers			
AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STAGE
Frank Webster, George Henson	1 January 1967	Init	Op

A. PURPOSE OF PROGRAM

To compute a stability analysis of a retaining wall. To make a plot of the retaining wall stability analysis complete with wall section, load and force diagrams, resistance to sliding values, and notes, for use as a design memorandum plate.

B. PROGRAM SPECIFICATIONS

CARD FORTRAN using plotter subroutines.

This is a two part program. The first part computes loads, etc.
The second part writes a plotter tape.

C. METHODS

Method derived by Structural Section of the Design Branch, Engineering Division, Tulsa District.

D. EQUIPMENT DETAILS

GE-225, 8K, Magnetic Tapes, Card Reader and Printer
Plotter tape on No. 2
Output tape on No. 3
30-inch paper for plotter
Start pen in center of paper.

E. INPUT-OUTPUT

Input - Cards and Magnetic.

Output - Magnetic Tape and Printer.

F. ADDITIONAL REMARKS

Assumptions: Length of retaining wall is one foot, vertical force values are the same on the toe section and heel section. Moments are taken about the outside edge of the toe base, and moments due to resistance to sliding are not considered in the stability of the structure. This program is for cantilever type of retaining wall.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.
Concrete General Flexure Analysis-CGFA			713-F3-E0010

PREPARING AGENCY

USAE Waterways Experiment Station, P. O. Box 631, Vicksburg, MS 39180

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STATUS OF PROGRAM: STAGE
E. T. Gates, SWGAD H. L. Miller, NPS	December 1974	Mod	Oper

A. PURPOSE OF PROGRAM

Elastic analysis of combined axial load plus bi-axial bending due to the axial load on a cracked section.

B. PROGRAM SPECIFICATIONS

The program is written in G-6000 FORTRAN, adapted to time-sharing from a G-200 FIZ card FORTRAN program. The time-sharing on-line library file name is CGFA.

C. METHODS

Working from an initial assumption that the neutral axis is on the coordinate x-axis, the program adds the correction terms to the stress equation until the neutral axis is located precisely enough to compute stresses within the specified precision (default precision is 0.1%).

D. EQUIPMENT DETAILS

Remote time-sharing terminal
G-635 computer

E. INPUT-OUTPUT

Terminal input: Name of saved data file
Saved file input (free-field): Problem name, concrete outline and steel pattern identification numbers, x and y coordinates of corners of concrete outline and of single bars or end bars of rows, bar areas, loading values of P, Mx, and My, N=Es/Ec, r=fs/nfc, precision. Terminal output includes data echo, stress equation and the neutral axis location, stress at each coordinate point and bar row end.

F. ADDITIONAL REMARKS

1. This program originated in the Seattle District in 1967.
2. Data for round cross-sections and circular areas can be generated by time-sharing program CGFARD.
3. Manipulation of input values of n and r will permit analysis of base plates, contact bearing, and homogeneous materials.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM				PROGRAM NO.
CGFARD Round Data Generator for Program 713-F3-E0010 (CGFA)				713-F3-R0011
PREPARING AGENCY USAE Waterways Experiment Station, P. O. Box 631, Vicksburg, MS 39180				
AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM		
		PHASE	STAGE	
William A. Price, Struct Engr FTS Phone 601-636-3645	December 1974		Oper	

A. PURPOSE OF PROGRAM

To generate concrete outline and/or steel pattern data cards for use with Program 713-F3-E0010, "Concrete General Flexure Analysis" (CGFA), working from the usual papameters used to describe reinforced concrete construction x or by defining radii and bar sizes and locations.

B. PROGRAM SPECIFICATIONS

The program is written in G-6000 FORTRAN.

C. METHODS

37 coordinates sets are generated for the concrete outline circle; if the radius of a concentric void is coded, a total of 74 coordinate sets are generated for the complete concrete outline description plus a repeat of the first set. The specified number of reinforcing bars are equally spaced in a concentric circle, with one bar on the +Y-axis.

D. EQUIPMENT DETAILS

G-635 computer
Remote terminal (asynchronous)

E. INPUT-OUTPUT

Terminal Input: X and Y coordinates of center of cross-section, radii of concrete outline and concentric void (if any), quantity and size number of reinforcing bars, clear cover over the bars, and identification number codes for the concrete and steel lines to be generated.
Output: Writes a data file to which load data lines are added to make a complete data file for CGFA.

F. ADDITIONAL REMARKS

1. The concrete lines can be omitted, for a circular steel pattern to be added to a non-circular concrete outline.
2. By computing two concrete outlines and discarding half of each set of concrete points, a rounded-end wall outline can be generated.
3. This is the time-sharing version of program 713-G1-M3170.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.
POSMO-Axial Force, Shear, Moment at 1/10 Points			713-G1-M3180
PREPARING AGENCY			
U. S. Army Engineer District, Galveston			
AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STAGE
William A. Price, III	March 1972	Operational	

A. PURPOSE OF PROGRAM

After using a conventional frame or beam analysis to get beam or frame member end moments and forces, program FOSMO computes the axial force, shear force, and bending moment at the 1/10 points of each member.

B. PROGRAM SPECIFICATIONS

Program language: G-200 Series Card FORTRAN (FIZMOP or CARD).

No external functions. Program uses arithmetic statement functions and multiple replacement statements.

No switches

C. METHODS

Static equilibrium, summed to left of each 1/10 point of member length.

D. EQUIPMENT DETAILS

G-200 Central Processor with 8K memory
Console Typewriter Card Reader
Card Punch (for compilation only)
Line Printer
Magnetic Tape (FIZMOP system only)

E. INPUT-OUTPUT

Input(cards): Problem identification, load case identification, member load data, member end moments and force data.

Output(printer): Problem identification, load case identification, data echo; location, axial force, shear, moment at each 1/10-point of each member.

F. ADDITIONAL REMARKS

Program 713-G1-A1040 (GFRAME) will punch a complete POSMO data deck when desired.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM	PROGRAM NO.
SKNPL - Skin Plate System Design/Analysis	713-F3-M3510

PREPARING AGENCY
U. S. Army Engineer District, Galveston

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STATUS OF PROGRAM: STAGE
William A. Price FTS Phone Structural Engineer 542-3645	December 1969 Mod Dec 1974	MOD	OP

A. PURPOSE OF PROGRAM

Analysis and/or design of an orthogonal, planar steel skin plate and composite tee rib system. (Ribs may be any steel shape or the program will select a structural tee from an internal table of 26 WT's and ST's for minimum cost. Costs are computed for comparative designs, steel and welding costs included. Combined stress is checked in accordance with EM 1110-2-2702, for 2-D (planar) action.

B. PROGRAM SPECIFICATIONS

Written in G-6000 FORTRAN for the G-635 time-sharing computer.

C. METHODS

First order working stress theory, no plate diaphragm action.

D. EQUIPMENT DETAILS

G-635 computer with Datanet
Remote terminal

E. INPUT-OUTPUT

Interactive I/O with numerous programmed error checks with restart options. A chart of user control, describing the options at each decision point, is shown in paragraph six of the writeup.

F. ADDITIONAL REMARKS

Copies of the writeup are available from the: ADP Coordinator
Corps of Engineers Waterways
Experiment Station
P. O. Box 631
Vicksburg, MS 39180

Appendix C: Abstract of Southwestern Division Proposed Standard Programs

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.
EPVKS1			713-F3-M2-306
PREPARING AGENCY			
U. S. Army Engineer District, Fort Worth, Texas			
AUTHOR(S)	**DATE PROGRAM COMPLETED**	**STATUS OF PROGRAM** PHASE	STAGE
Thomas Jeffus	Dec 75	Complete	Op

A. PURPOSE OF PROGRAM

Computes wall and slab shears and moments resulting from lateral and vertical loads on lock-chamber structures.

B. PROGRAM SPECIFICATIONS

FORTRAN IV

C. METHODS

D. EQUIPMENT DETAILS

Honeywell G-635 computer
TSS

E. INPUT-OUTPUT

Teletype terminal

F. ADDITIONAL REMARKS

This program is written and documented with instructions.

Appendix D: Abstracts of Southwestern Division Approved Programs

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM	PROGRAM NO.
X0001 - Analysis of Beams by Direct Stiffness Method	713-F3-F4-01A

PREPARING AGENCY

U. S. Army Corps of Engineers Waterways Experiment Station

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STAGE
Bill Ashton Rock Island District	May 1975	MOD1	OP

A. PURPOSE OF PROGRAM

A computer program to analyze beams of variable cross section subjected to arbitrary loading.

B. PROGRAM SPECIFICATIONS

G-600 FORTRAN
Time-sharing system

C. METHODS

Program used principal of matrix structure analysis, using the displacement method.

D. EQUIPMENT DETAILS

Honeywell 635 computer
T/S

E. INPUT-OUTPUT

Input: Data may be entered interactively or from data file.
Output: Echo of data with appropriate description - then list displacements and rotations of each nodal point. Last output provides shears and moments at the ends of each beam element.

F. ADDITIONAL REMARKS

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.
X0002-Plane Pin Jointed Truss Analysis by Direct Stiffness			713-F3-F401B
PREPARING AGENCY			
U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi			
AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STATUS OF PROGRAM: STAGE
Bill Ashton	May 1975	MOD1	OP

A. PURPOSE OF PROGRAM

Analyze by direct stiffness plane pin jointed truss structures to obtain individual bar forces.

B. PROGRAM SPECIFICATIONS

Program is written in FORTRAN and operates on both fixed and floating point T/S.

C. METHODS

Solution by standard Gaussian elemination techniques for determination of individual bar forces. This program is used to: Assemble total truss structure stiffness from individual truss bar stiffness matrices - then, related equations and terms are modified to known boundary conditions. Thus, individual bar forces are determined by matrix solution by standard Gaussian elimination techniques of nodal point displacements.

D. EQUIPMENT DETAILS

Interactive T/S.
Honeywell G-635.

E. INPUT-OUTPUT

Input consists of number of nodal points and number of members, restraint at each nodal point, and Young's modulus for each member.

Output consists of X and Y displacements for nodal points, and also, truss bar forces and bar stresses. Additional information if provided by program.

F. ADDITIONAL REMARKS

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.
X0003-Analysis of Frames by Direct Stiffness Method			713-F3-F401C

PREPARING AGENCY

U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STATUS OF PROGRAM: STAGE
Bill Ashton	May 1975	MOD1	OP

A. PURPOSE OF PROGRAM

Computer program written to analyze frames of variable cross section subjected to arbitrary loading. It uses the principle of matrix structure analysis, using the displacement method.

B. PROGRAM SPECIFICATIONS

Program is written in FORTRAN and operates in both fixed and floating point.

C. METHODS

Solution by standard Gaussian elemination techniques for determination of individual member forces. Purpose is to analyze frames of variable cross-section subjected to arbitrary loading.

D. EQUIPMENT DETAILS

Interactive T/S
Honeywell G-635

E. INPUT-OUTPUT

Input consists of number nodal points and frame members, numbering same, inputting nodal point restraints, X and y coordinates and displacements, and moments. Then for members, listing nodal point numbers at each end, member area, Young's modulus, moment of inertia, and element code.
Output will list X and Y displacements, nodal point rotation, axial load, shear and moment on ends of each member.

F. ADDITIONAL REMARKS

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.
Grid Analysis by Direct Stiffness (X0004-GRID)			713-F3-F4-01D
PREPARING AGENCY			
U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi			
AUTHOR(S)	**DATE PROGRAM COMPLETED**	**STATUS OF PROGRAM** — PHASE	STAGE
Bill Ashton	May 1975	MOD1	OP

A. PURPOSE OF PROGRAM

Purpose of program is to obtain the shears, moments, and torques corresponding to the displacements and rotations of the total structure stiffness matrix of grid structures.

B. PROGRAM SPECIFICATIONS

Program is written in FORTRAN and operates in both fixed and floating point.

C. METHODS

Modified version of Gaussian Elimination is used to find displacements and rotations of the total grid structure stiffness matrix and thus, corresponding shears, moments, and torques are obtained by substitution into the individual grid element stiffness matrices.

D. EQUIPMENT DETAILS

Interactive T/S. Honeywell G-635.

E. INPUT-OUTPUT

Input - Number grid nodal points and grid members, input restraint code, X-Y coordinates, displacement, rotation, and torque. Then, nodal numbers for member ends, member area, Young's Modulus for member, moment of inertia, shear modulus, and torsion constant.

Output- consists of the displacement, rotation, and twist for each nodal point plus the corresponding shears, moments, and torques.

F. ADDITIONAL REMARKS

AD-A031 246   ARMY FOREIGN SCIENCE AND TECHNOLOGY CENTER CHARLOTTE--ETC F/G 9/2
CORPS-WIDE CONFERENCE ON COMPUTER-AIDED DESIGN IN STRUCTURAL EN--ETC(U)
AUG 76 R M WAMSLEY, F J BOURGEOIS, D DRESSLER

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ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.
Analysis of Space Truss by Direct Stiffness			713-G1-F401E

PREPARING AGENCY
U. S. Army Engineer District, Rock Island

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STATUS OF PROGRAM: STAGE
William D. Ashton	January 1971		

A. PURPOSE OF PROGRAM

The program computes joint deflections, member forces, and member stresses for space trusses subjected to joint loads and joint displacements.

B. PROGRAM SPECIFICATIONS

The program is restricted only by the size of available computer hardware.

C. METHODS

The direct stiffness method of analysis is the basis for the program. The program uses a banded elimination solver to solve the total structure stiffness matrix.

D. EQUIPMENT DETAILS

Minimum requirements include 8K words, card input, and live printer output for FORTRAN II.

E. INPUT-OUTPUT

Output provides listing of descriptive data for truss, joint deflections, member forces, and member stresses.

F. ADDITIONAL REMARKS

Program procedures are symbolically identical to analysis of Plane Frames, Computer Program 713-GI-F401C.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.
Arbitrary Two-Dimensional Stress Structures			713-G1-F4-02A
PREPARING AGENCY			
University of California, Berkeley, California			
AUTHOR(S)	**DATE PROGRAM COMPLETED**	**STATUS OF PROGRAM** — PHASE	STAGE
Dr. E. L. Wilson	N/A		

A. PURPOSE OF PROGRAM

Analysis of arbitrary two-dimensional stress structures using direct stiffness methods. (Finite Element Program)

B. PROGRAM SPECIFICATIONS

C. METHODS

Direct Stiffness Method of Matrix Analysis.
Element used is the quadrilateral. Solver is a block-banded Gaussian elimination solver.

D. EQUIPMENT DETAILS

Program requires storage greater than R.I.D. capability.

E. INPUT-OUTPUT

Input is description of structure and loading. Output is displacements and stresses for each specified nodal point or element.

F. ADDITIONAL REMARKS

OCE program 13-G2-20
(W. Ashton)

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM: Analysis and Design of Simple-Span Precast-Prestressed Highway or Railway Bridge	PROGRAM NO.: PCA 033

PREPARING AGENCY: Portland Cement Association

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM — PHASE	STATUS OF PROGRAM — STAGE
Clifford L. Freyermuth			OP

A. PURPOSE OF PROGRAM

The program performs the analysis and design of simple-span, precast-prestressed highway or railway bridges. It will accommodate any section which can be adequately described by the input variables.

B. PROGRAM SPECIFICATIONS

FORTRAN

C. METHODS

Four modes are available in the program: (1) analysis and design of standard sections with a composite deck; (2) analysis and design of non-composite standard sections; (3) analysis and design of noncomposite single and double-celled box beams; and (4) analysis and design of all sections when the number and location of prestressing strands are included in the input data.

D. EQUIPMENT DETAILS

G-635 BATCH

E. INPUT-OUTPUT

INPUT data consists of up to 58 items, depending on the type of bridge and mode selected. Input must fully describe the section selected with regard to area, moment of inertia, dimensions, neutral axis location, concrete strengths, prestressing steel strength and area, allowable tensile stresses, etc. Other data describe loading conditions, prestressing geometry, span, input/output devices, and level of output.

OUTPUT - Stresses at extreme fibers due to initial pressures, beam weight plus initial prestress, beam weight, plus dead load plus final prestress, and all loads plus final prestress are tabulated for up to four points which may be designated in the input data.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM MDCF-Prismatic Member Moment Distribution Coefficient Formulas	**PROGRAM NO.** 713-F3-M3500
PREPARING AGENCY U. S. Army Engineer District, Galveston, P. O. Box 1229, Galveston, TX 77550	

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STATUS OF PROGRAM: STAGE
William A. Price FTS Phone: Structural Engineer 542-3645	August 1964 Mod October 1974	MOD	Oper

A. PURPOSE OF PROGRAM

To compute fix-end moments, shears, and equivalent-moment trapezoidal load; and simple-span shears; of any combination of point, uniformly distributed, or trapezoidally distributed loadings. The loadings can also include couples at any locations. Distributed loads can be over all or any portion of the span.

B. PROGRAM SPECIFICATIONS

Written in G-600 FORTRAN for the G-635 time-sharing computer system.

C. METHODS

1. 1957 Edition of Concrete Reinforcing Steel Institute Design Handbook, pages 72-73.
2. (Equiv. Trapez. Load) $ab=(36*FEM_{ab}-24*FEM_{ba})/L^2$

D. EQUIPMENT DETAILS

G-635 time-sharing computer
Remote low-speed terminal

E. INPUT-OUTPUT

Terminal I/O:
Input: Span, thickness (optional, for relative stiffness = t^3/L);
Load type code, distance to load, load value(s), distance to end of span from end of distribution load.
Output: FEM's, V-fixed's, V-simple-span's, Trapezoidal Load - at each end of span, t^3/L value if t given.

F. ADDITIONAL REMARKS

Documentation available from:
Engineer Computer Program Library
USAE Waterways Experiment Station
P. O. Box 631
Vicksburg. Mississippi 39180

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM
Cantilever Retaining Wall Stability (Q) & (S) Cases

PROGRAM NO.
741-F3-A2-370

PREPARING AGENCY
U. S. Army Engineers, New Orleans District

AUTHOR(S)
Michail C. LaMarea

DATE PROGRAM COMPLETED
April 1974

STATUS OF PROGRAM
PHASE: MOD2
STAGE:

A. PURPOSE OF PROGRAM

Determines the penetration of a cantilever retaining wall subjected to lateral forces that impart overturning moments. Computes lateral earth forces and overturning moments for each foot of depth and balances each to satisfy stability requirements of the method of planes.

B. PROGRAM SPECIFICATIONS

The program is written in Series 600 time-sharing FORTRAN. The program will analyze either the (S) Case, cohesion=0, or (Q) Case, cohesion≠0. It is limited to the following: static water condition, sheet pile impervious, no water seepage pattern developed. The program is designed to analyze a maximum of 12 strata with 24 points on each stratum profile.

C. METHODS

Conventional method of planes with some minor modifications is used to evaluate the stability of the cantilever retaining wall. Stability requires that for a given factor of safety the horizontal earth and water forces are in balance ($\sum F=0$) and the overturning moments of these forces about the bottom of the wall are in balance ($\sum M=0$).

D. EQUIPMENT DETAILS

The program is written for the WES G-635 HIS time-sharing system and is executed from a low speed remote terminal.

E. INPUT-OUTPUT

Input is punched on a paper tape and fed into a pre-assigned data file. Input consists of six basic types. Type 1 specifies whether or not tension cracks are to be computed. Type 2 consists of title and job identification. Type 3 contains head and tail water, upper and lower tip range, factor of safety, total number of strata, and elevation of bottom profile at the pile. Type 4 contains the dynamic wave force and elevation. Type 5 contains the soil properties for each stratum, one line of data for each stratum. Type 6 contains the coordinates for each profile. Output is by means of the teletype paper carriage and consists of active and passive pressures and cohesions developed, net pressure, water pressure on the protected and floodside of the pile, and the design elevation which satisfies stability of $\sum F=0$ and $\sum M=0$.

F. ADDITIONAL REMARKS

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM		PROGRAM NO.
Beams (Shear, Moment, Deflection)		713-F3-A2-580
PREPARING AGENCY		
U. S. Army Engineers, New Orleans District		

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STAGE
Denis J. Beer	April 1974	MOD2	

A. PURPOSE OF PROGRAM

The program will select from a file and/or analyze a symmetrical straight member of any statically determinant one-dimensional load system which consists of tranverse point loads, transverse continuous loads, and/or couples. It will calculate the transverse shear force, bending moment, and deflection from a chosen reference line for cross sections of the beam chosen by the program for analysis.

B. PROGRAM SPECIFICATIONS

The program is written in Series 600 time-sharing FORTRAN. The program is limited to 50 defining loads of the load system which consists of point loads or continuous loads which act normal to the long axis and in the plane of the member or couples which act perpendicular to this plane. The beam length and the number of point loads and couples is limited by each other as follows: Beam length (feet) $<$ 70-2n where n = number of point loads and couples $<$ 35.

C. METHODS

After reading in the load system, some physical and geometric properties, and indicators to define the system, the program calculates the statically determinant resultants at the support(s) by statics. It determines the transverse shear force and beiding moments at selected appropriate beam cross sections by strength of material principals and statics. The best member to support the load can then be chosen by the program from a list based on the section modulus. Deflections of the cross sections along perpendiculars from the unloaded configuration of the beam and from a chosen reference tangent to the deflected beam are then determined by the Moment-Area Method.

D. EQUIPMENT DETAILS

The program is written for the WES G-635 HIS time-sharing system and is executed from a low speed remote terminal.

E. INPUT-OUTPUT

Input data consists of the following: indicator values; a job title; the number of external supports; the beam coordinate of the ends of the member at which the analysis is to begin and end, of the reference of the deflection, of the lower end of the concrete wall, and of the point(s) of support; Young's modulus, the factor of safety; and the load system entered as follows for each load; the code of the type of load, member coordinate of application, and the directional magnitude of the load.

Output consists of the following printed data depending on the choice of the user: all data listed for the input less the indicators, the name of the member chosen either by the user or by the program, the physical properties of the member that were used by the program, and a list of beam coordinates of the cross sections chosen for analysis and the corresponding transverse shear force, shear stress, bending moment, and deflection of the member from a chosen tangent to the beam and/or the unloaded configuration of the beam.

F. ADDITIONAL REMARKS

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.
3D Pile Foundation Analysis - PHI Batter			713-G1-M413A
PREPARING AGENCY Little Rock District			
AUTHOR(S) Bill James	DATE PROGRAM COMPLETED August 1963	STATUS OF PROGRAM PHASE	STAGE

A. PURPOSE OF PROGRAM

Determine the individual pile loads for a group of piles including battered and vertical piles. The program computes the axial and transverse loads on each pile for given load conditions.

B. PROGRAM SPECIFICATIONS

1. Applied loads may be 3-dimensional.
2. Pile batter is limited to 2-dimensions.
3. Pile cap is rigid with horizontal base, unstepped.
4. Pile heads are hinged.
5. Lateral to axial pile stiffnesses ratios are equal for all piles in each group.
6. Pile loads are proportional to displacements.

C. METHODS

The program is based on the analysis procedure described in "Analysis of Pile Foundations with Batter Piles," by A. Hrennikoff, ASCE Trans 1950, Paper No. 2401, Vol 115 pp 351-381. The author modified the analysis to handle a three dimensional loading system.

D. EQUIPMENT DETAILS

GE-225 (8K), card input, line printer output. Language is FORTRAN.

E. INPUT-OUTPUT

Input - Project identification, applied loads, number of pile groups, stiffness ratios, geometry and batter angles for each group and designated piles for which computed loads are desired in printed output.

Output - Axial and transverse loads on individual piles as requested.

F. ADDITIONAL REMARKS

Galveston District program 713-G1-M4130 is identical except input option is added to simplify organization of input data.

Appendix E: Abstracts of District Programs

(1) Albuquerque
(2) Fort Worth
(3) Little Rock

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM	PROGRAM NO.
Indeterminate Frame Analysis (Concrete Box Culvert Frame Analysis and Design)	713-G1-M1-070

PREPARING AGENCY
U.S. Army Engineer District, Albuquerque District, Albuquerque, New Mexico

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STATUS OF PROGRAM: STAGE
Jack J. Miller	September 1975	Modified	Operations

A. PURPOSE OF PROGRAM

To rapidly and conveniently analyze and design simple concrete frames, particularly box culverts or conduits under high fills. The analysis is limited to uniformly or triangularly loaded prismatic or haunched members which are not subject to significant sidesway or deflection.

B. PROGRAM SPECIFICATIONS

The program is written in FORTRAN IV for the GE-437 and the GE-635 computers and is an integral part of the Conversationally Oriented Real Time Program - Generating System (CORPS), a Time-Sharing System.

C. METHODS

1. C of E EM 1110-2-2902, 3 Mar 1969, "Conduits, Culverts and Pipes."
2. ACI 318-71.
3. Statically Indeterminate Structures, by Chu-Kia Wang; McGraw-Hill Book Co., Inc., 1953.
4. Concrete Plain and Reinforced by Taylor, Thompson, and Smulski; John Wiley and Sons; Fourth Edition, May 1955.
5. Columns by Ultimate Strength Design by R. C. Reese for Concrete Reinforcing Institute, First Edition, 1967.

D. EQUIPMENT DETAILS

1. GE-437 with remote GE-225 input-output.
2. GE-635 with remote time-sharing terminal.

E. INPUT-OUTPUT

Input consists of the following: Frame description integers, alphanumeric problem description, concrete compressive strength, yield strength of reinforcing steel, a test integer to provide compressive reinforcing steel, a test and data variable (UTEST), clear span of member, beam depth, beam width, haunch depth, cover over reinforcing steel and load vectors.

Output is in tabular form with headings, frame illustration, input date, fixed end moments, distribution factors, carryover factors, distributed moments, shears, thrusts, flexure design data, anchorage lengths, and shear design data.

F. ADDITIONAL REMARKS

Complete documentation will be available from the Engineer Computer Program Library Technical Services Division, WES. Earlier analysis versions of this program have been published and disseminated by USAED and IBM under the title "Indeterminate Frame Analysis" dated August 1962. Since 1962, analysis and design versions (undocumented) have been disseminated by USAED, Albuq, NM only when specifically requested by other users.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.
Flexible Culvert Pipe - Arch Analysis			713-J2-M1010
PREPARING AGENCY			
Albuquerque District, Corps of Engineers			
AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STAGE
Jack J. Miller	June 1961 Rev 1972		OP

A. PURPOSE OF PROGRAM

To analyze flexible culvert pipe-arches.

B. PROGRAM SPECIFICATIONS

The program is written in FORTRAN IV for the GE-225 computer.

C. METHODS

The compression ring theory is used to compute seam strength and soil pressures. Flexibility is computed from Armco's empirical formula:

$$K = \frac{D^2}{I}$$

See <u>The Corrugated Metal Conduit as a Compression Ring</u>, By L. H. White and J. P. Layer, Jan 60, for Armco Drainage and Metal Products, Inc.

D. EQUIPMENT DETAILS

GE-225 with card reader and printer.

E. INPUT-OUTPUT

Input - Pipe arch dimensional data, fill height and increment, maximum allowable corner pressure and unit weight of fill.

Output - Load per foot of seam, corner pressure, gauge needed and flexibility factor.

F. ADDITIONAL REMARKS

Originally written as a classroom problem but is now used as a "time saver" in design.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM	PROGRAM NO.
CANTILEVER RETAINING WALL	713-G2-L3-003

PREPARING AGENCY U. S. Army Engineer District San Francisco Corps of Engineers, 100 McAllister St. San Francisco, California 94102

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STAGE
J. D. Rafferty	April 1971	MOD	

A. PURPOSE OF PROGRAM

This program investigates a given section or determines the dimensions and designs the reinforcing steel for a cantilever retaining wall.

B. PROGRAM SPECIFICATION

FORTRAN IV (H)

C. METHODS

Wall dimensions are based upon the criteria set forth in EM 1110-2-2502 for sliding, over-turning and stability. Working stress methods in accordance with EM 1110-1-2101 are used in the concrete design.

D. EQUIPMENT DETAILS

GE 400 series computer (32k words), card reader, printer. Tape or disc storage required. Program required 8k decimal words on the DAPS oriented GE 415 computer.

E. INPUT-OUTPUT

Card punched input. Input consists of soil data cards, design criteria cards, stem data cards, section data card, loading data cards, and soil type data card.

Output via printer. Output includes input data, volumn concrete and steel reinforcement for stem and base design.

F. ADDITIONAL REMARKS

Modifications were made to combine two decks into one and to reduce the number of runs required from four to one.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.
Beam on Elastic Foundation			713-J2-M0122
PREPARING AGENCY			
Albuquerque District, Corps of Engineers			
AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STATUS OF PROGRAM: STAGE
Joe Avant			OP

A. PURPOSE OF PROGRAM

To analyze the base slab of U-frame structures.

B. PROGRAM SPECIFICATIONS

The program is written in FORTRAN IV and adapted to the GE-225 computer.

C. METHODS

The method of analysis is based on theory presented in <u>Beams on Elastic Foundations</u> by M. Hetenyi.

D. EQUIPMENT DETAILS

GE-225, card reader and printer.

E. INPUT-OUTPUT

Input - Structure dimensional information, material properties, unit weights and loadings.

Output - Slopes, shears, deflections and moments in slab with base pressures.

F. ADDITIONAL REMARKS

Partially documented.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM	PROGRAM NO.
Analysis of Continuous Beams for Highway Bridges IV	713-K5-G3-020

PREPARING AGENCY

State Highway Department of Georgia

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STATUS OF PROGRAM: STAGE
Jose M. Nieves-Olmo Rev. by: Glenn H. Sikes			

A. PURPOSE OF PROGRAM

This program performs the complete analysis of a continuous beam for a highway bridge and reports the moments, stresses, shears, reactions, deflections and shear connector spacings produced by the dead loads and the standard highway line loads (including the special military loading and the sidewalk line load) defined by the AASHTO "Standard Specifications for Highway Bridges," 1969, Interims 1970, 1971.

B. PROGRAM SPECIFICATIONS

FORTRAN IV

C. METHODS

Classical theories for the analysis of statically indeterminate structures are used. Simpson's method is used to elevated the integrals required to compute the elastic properties of the beam and influence line areas. Moment-Area Theorems and Maxwell's Law of Reciprocal Deflections are used to compute deflections and influence lines for deflections. One cycle Moment Distribution is used for the distribution of fixed-end moments.

D. EQUIPMENT DETAILS

IBM 360, Mod. 50
Card Reader, Printer

E. INPUT-OUTPUT

Input - Cards
Output - Printer

F. ADDITIONAL REMARKS

For a detailed description of the Method of Solution, see Vol 1 of the write-up, "The Analysis of Continuous Beams for Highway Bridges," written for the IBM 650 computer.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM
XSPROP

PROGRAM NO.

PREPARING AGENCY
U.S. Army Engineer, Fort Worth District, Fort Worth, Texas

AUTHOR(S)
Thomas Jeffus

DATE PROGRAM COMPLETED
November 1972

STATUS OF PROGRAM
PHASE
STAGE

A. PURPOSE OF PROGRAM

This program computes the geometric properties of any composite V-section which can be represented by 100 rectangular sections or less.

B. PROGRAM SPECIFICATIONS

FORTRAN IV

C. METHODS

D. EQUIPMENT DETAILS

GE-635 time-sharing system

E. INPUT-OUTPUT

F. ADDITIONAL REMARKS

Partial documentation is available from Fort Worth District.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM			PROGRAM NO.
BMCØL 3			
PREPARING AGENCY			
U.S. Army Engineer, Fort Worth District, Fort Worth, Texas			
AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM: PHASE	STAGE
Thomas Jeffus	December 1970		

A. PURPOSE OF PROGRAM

This program analyzes continuous beams on elastic foundation.

B. PROGRAM SPECIFICATIONS

FORTRAN IV

C. METHODS

1. A finite-element-model approach to derivation of the difference equations.
2. A recursion method which is used for solving the system of equations.

D. EQUIPMENT DETAILS

G-635 Time-Sharing System

E. INPUT-OUTPUT

F. ADDITIONAL REMARKS

Originally written in FORTRAN II for the IBM-1620. Revised by Fort Worth District. Documentation available from T. Jeffus of Fort Worth District.

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM Two Column Bent Highway Bridge			**PROGRAM NO.** 713-G1-M4-350
PREPARING AGENCY U.S. Army Engineer, Little Rock District, Little Rock, Arkansas			
AUTHOR(S) F. J. Kitchens, Jr. Rev. by: Bob Halliburton	**DATE PROGRAM COMPLETED** October 1965	**STATUS OF PROGRAM** **PHASE**	**STAGE** OP

A. PURPOSE OF PROGRAM

The program determines the moments, shears and reactions necessary for the design of a two-column bridge bent with or without a strut at the base of the columns. Given the bent geometry and loading conditions, the program determines column data due to unit loads, wind loads, dead and live load cases furnished by input data. The dead load, wind loads, and all live load cases are combined to give the most critical moments and shears for the cap design.

B. PROGRAM SPECIFICATIONS

FORTRAN

C. METHODS

Final end moments due to the given loads are determined using the moment distribution method of analysis. If no strut, the degree of fixity of the columns at the footings is determined by the value entered for CE. If there is a strut the distribution factors at the strut are determined the same as the cap (i.e., proportion to the relative stiffness of the members framing into the joint). The member geometry furnished by the input data is used to compute the moment of inertia.

D. EQUIPMENT DETAILS

GE-225
Card Reader
Card Punch
900 LPM Printer
8K Memory

E. INPUT-OUTPUT

Input - Cards
Output - Cards and Print

F. ADDITIONAL REMARKS

Originally from Savannah District (713-G1-K6-080).

Appendix F: Southwestern Division Regulations

DEPARTMENT OF THE ARMY
Southwestern Division, Corps of Engineers
1114 Commerce Street
Dallas, Texas 75202

SWDDC-F/SWDAD

Regulation
No. 37-1-7

15 February 1972

FINANCIAL ADMINISTRATION
Standardization of Computer Programs

1. Purpose. This regulation prescribes the policy and procedures to be followed in the assignment of lead responsibility for development of uniform computer programs, for business and technical applications of the districts, and the financing thereof.

2. Applicability. This regulation applies to all districts within the Southwestern Division.

3. References.

a. ER 37-2-10
b. ER 37-345-10

4. General. Existing programs, systems, and/or proposed applications recommended by the districts for standardization throughout the Division should be submitted to this office, ATTN: SWDAD. No program or system will be approved for standardization until the proposed application has been circulated to SWD districts for comments by the potential users. Upon adoption of a proposed standard application the cost of development will be borne by all districts in proportion to each district's potential use.

5. Procedures.

a. After approval of a standard application one of the benefiting districts (usually the submitting district) will be assigned the lead responsibility in the development, and/or refinement, of the approved application based on the capabilities and work load of that district.

b. The designated lead district will submit an estimate of costs to be incurred to this office, ATTN: SWDDC. Each benefiting district will be notified by this office of the estimated costs they will be expected to bear. Based on this estimate each district will furnish the lead district a DA Form 2544.

c. Billings will be submitted to the benefiting districts at least quarterly, or upon completion of the study, whichever is earlier, and will include a statement as to the estimated percentage of completion.

This regulation supersedes SWDR 35-1-3, 18 October 1967

SWDAD

DEPARTMENT OF THE ARMY
Southwestern Division, Corps of Engineers
1114 Commerce Street
Dallas, Texas 75202

SWDR 18-1-1

Regulation
No. 18-1-1

19 July 1972

MANAGEMENT INFORMATION SYSTEMS
AUTOMATIC DATA PROCESSING

1. Purpose. This regulation establishes policy and responsibility for actions in area of automatic data processing (ADP).

2. Applicability. This regulation applies to all districts within the Southwestern Division and the Division Office.

3. Policy. The rapid expansion of the use of computers in the Federal Government has been of great concern to Congress, Office of Management and Budget, Department of Defense and Department of the Army (DA). This concern has resulted in many directives and restrictions covering almost every activity in the field of automatic data processing. In order to minimize conflict with these regulations, all ADP actions shall either be originated by the ADP Coordinator or shall be coordinated closely with him at the inception of the proposed action.

4. Responsibility. The District and Division ADP Coordinators shall be responsible for proper procedure on all actions pertaining to automatic data processing. These specifically include, but are not limited to, the following:

a. Procurement of all ADP equipment, as defined by AR 18-1. This procurement requires DA approval.

b. Procurement of auxiliary equipment (such as punched card machines, terminals, etc.). Some of this can be approved by Office, Chief of Engineers (OCE).

c. Procurement of time on other computers. The Division Engineer has limited authority in this area. General Services Administration (GSA) prior concurrence shall be obtained. See AR 18-7.

d. Procurement of other ADP services, which includes systems analysis, systems design, programing, programs, etc., that may be obtained commercially or within the Government. GSA prior concurrence may be required.

e. Approval for the origination of new computer programs and computer system analyses. No new programs shall be developed without a thorough search for existing programs that may be utilized. Prior

approval shall be obtained from the Division ADP Coordinator before starting any new system study or any new program of any type.

f. Securing and maintaining proper documentation for all computer programs in use in the ADP Center. See AR 18-7.

g. The release of any Corps of Engineers computer program to anyone. Conditions for a release are set forth in ER 18-1-6.

5. Use of Computer Facilities. Instruction for use of the Southwestern Division Office central computer facilities will be issued as soon as desirable operating procedures are determined. Each District ADP Center should establish local instructions concerning correct procedure for using the local ADP facilities. These instructions should cover such items as initiation of system or program development, required documentation, job request cards, and requirements for retention of tape or card files.

FOR THE DIVISION ENGINEER:

RALPH J. BOVE
Major, MPC
Executive Officer

DISTRIBUTION:
A; B; C

In accordance with ER 70-2-3, paragraph 6c(1)(b), dated 15 February 1973, a facsimile catalog card in Library of Congress format is reproduced below.

Corps-Wide Conference on Computer-Aided Design in Structural Engineering, New Orleans, La., 1975.
[Proceedings ... held in New Orleans, Louisiana, 22-26 September 1975] Vicksburg, Miss., Automatic Data Processing Center, U. S. Army Engineer Waterways Experiment Station, 1976-
12 v. illus. 27 cm.
Contents.-v.1. Management report.-v.2. List of computer programs for CADSE.-v.3. Invited speeches and technical presentations.-v.4. Division presentations.-v.5. State-of-the-Corps-Art (SOCA) reports on gravity monoliths, U-frame locks, and channels.-v.6. SOCA reports on gates, stoplogs, and trashracks.-v.7. SOCA reports on single- and multiple-cell conduits and tunnels.-v.8. SOCA reports on pile foundations and sheet pile cells.-v.9. SOCA reports on sheet pile walls and T-walls.-v.10. SOCA reports on stiffness methods, frames, and military construction.-v.11. SOCA reports on earthquake and dynamic analyses.-v.12. Interactive graphics, SEARCH and CORPS systems.

(Continued on next card)

Corps-Wide Conference on Computer-Aided Design in Structural Engineering, New Orleans, La., 1975.
[Proceedings ...] 1976-
(Card 2)

1. Computer-aided design -- Congresses. 2. Design -- Congresses. 3. Structural engineering -- Congresses. I. U. S. Army. Corps of Engineers. II. U. S. Waterways Experiment Station, Vicksburg, Miss.
TA641.C67 1975